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SIR:

CERTIFIED TRANSLATION

I, Tatsuhiro Mochizuki, am an official translator of the Japanese language into the English language and I hereby certify that the attached comprises an accurate translation into English of Japanese Application No. 2000-132918, filed on April 27, 2000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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[Title of the Invention]

Signal Processing Device and Signal Processing Method

[Claims]

[Claim 1]

A signal processing device comprising:

a first signal section detecting means for detecting a first signal section from an input signal including at least the first signal section and the remaining signal section on a time division basis;

a first signal extracting means for extracting the signal in the first signal section from the input signal in accordance with a result of the detection by the first signal section; and

a recording means for recording the extracted first signal.

[Claim 2]

The signal processing device according to claim 1, further comprising a characteristic value extracting means for extracting the characteristic values characterizing the first signal from the extracted first signal, wherein said recording means records the characteristic values.

[Claim 3]

The signal processing device according to claim 1, wherein said first signal

section detecting means detects said first signal section from said input signal on the basis of a characteristic pattern of the signal appearing in said input signal at predetermined time intervals and a characteristic value showing the probability of the first signal.

[Claim 4]

The signal processing device according to claim 1, wherein said first signal section detecting means detects said first signal section on the basis of predetermined guide information which is prepared corresponding to said input signal.

[Claim 5]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is amplitude of the signal in the first signal section.

[Claim 6]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is a spectrum of the signal in the first signal section.

[Claim 7]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is a linear prediction coefficient

of the signal in the first signal section.

[Claim 8]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is a histogram of a predetermined component of the signal in the first signal section.

[Claim 9]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is mean value of the predetermined component of the signal in the first signal section.

[Claim 10]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is difference of the predetermined signal component of the signal in the first signal section.

[Claim 11]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is the number of changes of the state of the signal in the first signal section.

[Claim 12]

The signal processing device according to claim 2, wherein said characteristic value characterizing said first signal is the time of the change of the

state of the signal in the first signal section.

[Claim 13]

The signal processing device according to claim 1, further comprising:

an index information extracting means for extracting information to be used as an index representing said recorded first signal; and

a display means for displaying said extracted index information.

[Claim 14]

The signal processing device according to claim 13, wherein said index information is an edited signal obtained by editing said first signal.

[Claim 15]

The signal processing device according to claim 14, wherein said edited signal obtained by editing said first signal comprises a set of signals at the time when the state of said first signal changes.

[Claim 16]

The signal processing device according to claim 14, wherein said edited signal obtained by editing said first signal comprises a signal representing a starting part of said first signal and/or a signal representing an ending part of said first signal.

[Claim 17]

The signal processing device according to claim 13, wherein said index

information extracting means extract the signal at a time when the state of said first signal changes.

[Claim 18]

The signal processing device according to claim 2, further comprising a comparing means for comparing characteristic values respectively characterizing different first signals.

[Claim 19]

The signal processing device according to claim 18, wherein said comparing means is detects agreement/disagreement of the first signals in a part of the section or in the entire section by comparing said characteristic values.

[Claim 20]

The signal processing device according to claim 18, wherein said comparing means detects the degree of similarity of the first signals in a part of the section or in the entire section by comparing said characteristic values.

[Claim 21]

The signal processing device according to claim 18, wherein said comparing means performs the comparing operation on a basis of the distance as determined by using a predetermined distance scale between vectors formed at least one of the amplitude of the signal in the first signal section, the spectrum of the signal in the first signal section, the linear prediction coefficient of the signal in the

first signal section, the histogram of a predetermined component of the signal in the first signal section, the mean value of the predetermined component of the signal in the first signal section, the difference in the predetermined signal component of the signal in the first signal section, the number of changes in the state of the signal in the first signal section and the time of a change in the state of the signal in the first signal section.

[Claim 22]

The signal processing device according to claim 13, further comprising:

an index information specifying means for specifying desired index information from said displayed plurality of pieces of index information; and

a retrieving means for retrieving the first signal corresponding to said specified index information.

[Claim 23]

The signal processing device according to claim 2, further comprising:

a retrieving means for retrieving the first signal substantially agreeing with said first signal from said recording means, using said first signal in a part of the section or in the entire section or a characteristic value characterizing the first signal as retrieving condition.

[Claim 24]

The signal processing device according to claim 2, further comprising:

a retrieving means for retrieving the first signal substantially agreeing with said first signal from said recording means, using a part or all of said first signal or a characteristic value characterizing the first signal as retrieving condition.

[Claim 25]

The signal processing device according to claim 1, further comprising:

a measuring means for measuring the number of times and/or the hours of appearances of a same first signal.

[Claim 26]

The signal processing device according to claim 1, further comprising:

a measuring means for measuring the number of times and/or the hours of appearances of similar first signals.

[Claim 27]

A signal processing method comprising the steps of:

detecting a first signal section from an input signal containing at least the first signal section and the remaining signal section on a time division basis;

extracting the signal of the first signal section out of the input signal in accordance with to the result of the detection of the first signal section; and

recording the extracted first signal.

[Claim 28]

The signal processing method according to claim 27, further comprising the

steps of:

extracting the characteristic values characterizing the first signal from the extracted first signal; and

recording the characteristic values.

[Claim 29]

The signal processing method according to claim 27, wherein said first signal section detecting step is adapted to detect said first signal section from said input signal on the basis of a characteristic pattern of the signal appearing in said input signal at predetermined time intervals and a characteristic value showing the probability of the first signal.

[Claim 30]

The signal processing method according to claim 27, wherein

said first signal section detecting step is adapted to detect said first signal section on a basis of predetermined guide information which is prepared to correspond to said input signal.

[Claim 31]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is amplitude of the signal in the first signal section.

[Claim 32]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is a spectrum of the signal in the first signal section.

[Claim 33]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is a linear prediction coefficient of the signal in the first signal section.

[Claim 34]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is a histogram of a predetermined component of the signal in the first signal section.

[Claim 35]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is mean value of the predetermined component of the signal in the first signal section.

[Claim 36]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is difference of the predetermined signal component of the signal in the first signal section.

[Claim 37]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is the number of changes of the state of the signal in the first signal section.

[Claim 38]

The signal processing method according to claim 28, wherein said characteristic value characterizing said first signal is the time of the change of the state of the signal in the first signal section.

[Claim 39]

The signal processing method according to claim 27, further comprising the steps of:

extracting information to be used as an index representing said recorded first signal; and

displaying said extracted index information.

[Claim 40]

The signal processing method according to claim 39, wherein said index information is an edited signal obtained by editing said first signal.

[Claim 41]

The signal processing method according to claim 40, wherein said edited signal obtained by editing said first signal comprises a set of signals at the time when the state of said first signal changes.

[Claim 42]

The signal processing method according to claim 40, wherein said edited signal obtained by editing said first signal comprises a signal representing a starting part of said first signal and/or a signal representing an ending part of said first signal.

[Claim 43]

The signal processing method according to claim 39, wherein said index information extracting step is adapted to extract the signal at a time when the state of said first signal changes.

[Claim 44]

The signal processing method according to claim 28, further comprising a comparing step for comparing characteristic values respectively characterizing different first signals.

[Claim 45]

The signal processing method according to claim 44, wherein said comparing step is adapted to detect the agreement/disagreement of the first signals in a part of the section or in the entire section by comparing said characteristic values.

[Claim 46]

The signal processing method according to claim 44, wherein said

comparing step is adapted to detect the degree of similarity of the first signals in a part of the section or in the entire section by comparing said characteristic values.

[Claim 47]

The signal processing method according to claim 44, wherein said comparing steps is adapted to perform the comparing operation on the basis of the distance as determined by using a predetermined distance scale between vectors formed at least one of the amplitude of the signal in the first signal section, the spectrum of the signal in the first signal section, the linear prediction coefficient of the signal in the first signal section, the histogram of a predetermined component of the signal in the first signal section, the average value of a predetermined component of the signal in the first signal section, the difference in a predetermined signal component of the signal in the first signal section, the number of changes in the state of the signal in the first signal section and the time of a change in the state of the signal in the first signal section.

[Claim 48]

The signal processing method according to claim 39, further comprising an index information specifying step for specifying desired index information from said displayed plurality of pieces of index information; and

a retrieving step for retrieving the first signal corresponding to said specified index information.

[Claim 49]

The signal processing method according to claim 28, further comprising a retrieving step for retrieving a first signal substantially agreeing with said first signal from said recording step, using said first signal in a part of the section or in the entire section or a characteristic value characterizing the first signal as retrieving condition.

[Claim 50]

The signal processing method according to claim 28, further comprising a retrieving step for retrieving a first signal substantially agreeing with said first signal from said recording step, using a part or all of said first signal or a characteristic value characterizing the first signal as retrieving condition.

[Claim 51]

The signal processing method according to claim 27, further comprising a measuring step for measuring the number of times and/or the hours of appearances of a same first signal.

[Claim 52]

The signal processing method according to claim 27, further comprising a measuring step for measuring the number of times and/or the hours of appearances of similar first signals.

[Claim 53]

The signal processing device according to claim 1, wherein said input signal comprises a video signal and/or an audio signal and said first signal covers a commercial message section.

[Claim 54]

The signal processing method according to claim 27, wherein said input signal comprises a video signal and/or an audio signal and said first signal covers a commercial message section.

[Detailed Description of the Invention]

[1]

[Technical Field of the Invention]

This invention is applied to an audio/video recording/reproduction apparatus. More particularly, the present invention relates to a signal processing device and a signal processing method that can be conveniently used for storing, viewing/listening to and/or retrieving commercial messages added to a television broadcast program.

[2]

[Prior Art]

Conventionally, television and radio programs are normally broadcast with commercial messages (to be referred to simply as CMs hereinafter) provided by one or more than one commercial companies and/or organizations and inserted into

the program with few exceptions that may charge a subscription fee.

[3]

Some of the viewers of such a program may feel that the CMs are not wanted while other may appreciate them as necessary and direct sources of commercial information particularly when they present famous actors and/or interesting scenes.

[4]

However, while the channels and the time slots of television and radio programs to be broadcast can be known in advance by referring to a published time schedule, it is not easy to know in advance the channel and the time slot of a particular CM. Therefore, it may be highly convenient to those viewers/listeners who want to view/listen to particular CMs if the CMs that are broadcast and/or to be broadcast are stored at a particular site so that any viewer/listener who wants to view/listen to a particular CM may access, retrieve and view/listen to it at any time he or she wants.

[5]

[Problems to be Solved by the Invention]

Japanese Patent Applications Laid-Open Publication Nos. 8-317342, 3-158086 and 3-2622872 proposes techniques for detecting CMs out of broadcast signals so that a viewer/listener can view/listen to a program by skipping the CMs

in the program. However, none of the above cited patent documents describe a technique for storing accessing, retrieving and viewing/listening to CMs.

[6]

Meanwhile, Japanese Patent Application Laid-Open Publication No. 10-224724 describes a technique of detecting information accompanying CMs, storing the information and replaying a same CM for once. However, the disclosed technique cannot be used to store, access, retrieve and view/listen to CMs. Additionally, the use of the disclosed technique is very limited because it cannot discriminate a stereophonic program and a CM that is broadcast in a stereo mode, although CMs are often broadcast in a stereo mode.

[7]

Therefore, there is a strong demand for a technique that can accurately detect CMs out of broadcast signals and also be used for storing, accessing, retrieving and viewing/listening to CMs.

[8]

In view of the above identified circumstances, it is therefore the object of the present invention to provide a signal processing device and a signal processing method that can accurately detect CMs out of broadcast signals and also be used for storing, accessing, retrieving and viewing/listening to CMs.

[9]

[Means to Solve the Problem]

According to the invention, the above object is achieved by providing a signal processing device comprising a first signal section detecting means for detecting a first signal section out of an input signal including at least the first signal section and the remaining signal section on a time division basis, a first signal extracting means for extracting the signal of the first signal section out of the input signal according to the result of the detection of the first signal section and a recording means for recording the extracted first signal.

[10]

In another aspect of the invention, there is also provided a signal processing method comprising steps of detecting a first signal section out of an input signal containing at least the first signal section and the remaining signal section on a time division basis, extracting the signal of the first signal section out of the input signal according to the result of the detection of the first signal section and recording the extracted first signal.

[11]

Thus, according to the invention, the first signal is detected out of the input signal and recorded and therefore, it is now possible to separate and sort out the first signal from the remaining signal section of the input signal. Additionally, according to the invention, it is easy to view, remove and/or detect the first signal

because some or all of the characteristic values characterizing the detected first signal can be recorded with the first signal itself. Still additionally, according to the invention, it is possible to extract and display the index information representing the first signal so that the first signal can be viewed and retrieved with ease. Furthermore, according to the invention, any duplicative parts of the recorded first signal can be removed to improve the recording efficiency and eliminate the possible waste of time of viewing a same signal for a number of times. Finally, according to the invention, the first signal can be used to detect a signal that is partly identical with or similar to the first signal.

[12]

[Preferred Embodiment of the Invention]

Now, the present invention will be described in greater detail by referring to the accompanying drawings that illustrate a preferred embodiment of the invention.

[13]

FIG. 1 is a schematic block diagram of a preferred embodiment of broadcast signal processing device according to the invention.

[14]

Referring to FIG. 1, the broadcast signal processing device is adapted to receive an input signal 200a that can contain a video signal, an audio signal, a control signal and a program guide signal. The input signal 200a may be a signal

that is received by way of a ground wave broadcasting system, a satellite broadcasting system, a cable broadcasting system or a telephone network or reproduced from some other recording device that has recorded the signal in advance. The video signal and the audio signal take a major part of the broadcast signal and contain the signals of a program itself and one or more than one CMs. The control signal includes information on the broadcasting, the time slot of broadcasting the program, the frequency of the wave or the channel to be used for the transmission of the signal. The program guide signal contains data related to the video signal and the audio signal when the signals are received in the case of digital broadcasting or by way of a telephone network. While it is assumed that the signals are those of a single broadcast program, the present invention is also applicable to signals that are input simultaneously by way of a plurality of channels.

[15]

Of the broadcast signal processing device shown in FIG. 1, the CM detecting section 202 detects at least the start time of each CM (to be referred to as CM start time hereinafter) and the length of the CM section (to be referred to as CM length hereinafter from the input signal 200a containing the video signal, audio signal, control signal and the program guide signal and outputs a CM detection signal 202a indicating the CM start times and the CM lengths. The operation of

the CM detecting section 202 will be described in greater detail hereinafter along with the CM start times and the CM lengths. The CM detection signal 202a detected by the CM detecting section 202 is then sent to the CM extracting section 201 and the CM characteristics extracting section.

[16]

The CM extracting section 201 extracts signal 201a that corresponds to the CM sections out of the input signal 202a on the basis of the CM detection signal 202a supplied from the CM detecting section 202. More specifically, the CM extracting section 201 extracts the signal sections corresponding to the CM sections as defined respectively by the CM start times and the CM lengths indicated by the CM detection signal 202a fed from the CM detecting section 202 and outputs CM part signals corresponding to the respective CM sections and containing video signals, audio signals, control signals and program guide signals respectively. The CM part signals 201a are sent to the CM recording section 205. Since the CM detection signal 202a from the CM detecting section 202 is delayed relative to the input signal 200a by the time period required for the detecting operation, the CM extracting section 201 is adapted to absorb the delay by using a temporary storage such as a magnetic recording device that is internally or externally provided.

[17]

The CM recording section 205 is in fact a device for recording and reproducing signals by using a magnetic tape, a magnetic disc, an opto-magnetic disc, a recordable optical disc and/or a semiconductor memory. Upon receiving the CM part signals 201a (including the video signals, the audio signals, the control signals and the program guide signals corresponding to the CM sections), the CM recording section 205 records the CM part signals 201a.

[18]

FIG. 2 is a schematic block diagram of a subset of the embodiment including only the CM extracting section 201, the CM recording section 202 and the CM recording section 205 and FIG. 3 is a flow chart of the operation of the subset of FIG. 2.

[19]

Referring to FIG. 3, as the video signals, the audio signals, the control signals and the program guide signals of the input signal 200a are sequentially input to the subset in step S220, the input signal 200a is stored in the internal or external temporary storage by the CM extracting section 201 in step S221.

[20]

At the same time, the CM detecting section 202 of the above subset detects the CM start times and the CM lengths of the CM sections. More specifically, the CM detecting section 202 detects each CM section out of the input signal 200a in

Step S222 and then processing operation proceeds to Step S223 when it is determined that the detected section is a CM section but to Step S225 when it is determined that the detected section is not a CM section.

[21]

In Step S223, the CM extracting section 201 extracts the signal 201a containing the video signal, the audio signal, the control signal and the program guide signal of the detected CM section. Then, in Step S224, the CM recording section 205 stores the extracted signal.

[22]

When the processing operation proceeds to Step S225, the signals temporarily stored by the CM extracting section 201 is discarded and the processing operation returns to Step S220 to repeat the above steps.

[23]

Referring back to FIG. 1, the CM characteristics extracting section 203 extracts CM characteristics out of the input signal 200a on the basis of the CM detection signal 202a fed from the CM detecting section 202. More specifically, the CM characteristics extracting section 203 extracts the characteristic values (representing some or all of the characteristics as CM as will be described hereinafter) of each of the signal parts contained in the CM detection signal 202a fed from the CM detecting section 202 and corresponding to the CM sections as

defined by the CM start times and the CM lengths and outputs the characteristic values 203a to the CM recording section 205. Note that, since the CM detection signal 202a fed from the CM detecting section 202 is delayed relative to the input signal 200a by the time period required for the detecting operation, the CM characteristics extracting section 203 is adapted to absorb the delay by using a temporary storage such as a magnetic recording device that is internally or externally provided. The temporary storage of the CM characteristics extracting section 203 may share the temporary storage of the CM extracting section 201.

[24]

The characteristic values for characterizing each of the CMs are extracted from the video signal and the audio signal. Part or all of the physical values of each CM including the amplitude characterizing value, the spectrum characterizing value, the linear prediction coefficient, the brightness histogram, the color histogram, the average luminance the luminance difference energy, the number of cut changes and the number of each cut change may be used for the purpose of the invention. These characteristic values shows a pattern that is identical to a CM and but different from that of some other CM so that they can be used to characterize the CM.

[25]

In the following description, it is assumed that the input audio signal and

the input video signal are discretized and the input audio signal is expressed by S[m] as shown in (b) of FIG. 4, where m = 0, 1, ..., M-1, representing discretized time periods, M being the discrete time corresponding to the frame being processed. Also assume that the input video signal is expressed by I[x, y; l], where l = 0, 1, ..., L-1, representing the video fame of the input image, L being the number of video frames corresponding to the processing frame, x = 0, ..., X-1, representing the pixel number in the horizontal direction, X being the horizontal image size, and y = 0, ..., X-1, representing the pixel number in the vertical direction, Y being the vertical image size. Note that the processing frame is the processing unit having a predetermined time length, which is typically 250ms. The number of frames corresponding to the length of a CM section is expressed by N as shown in (c) of FIG. 4.

[26]

Now, each characteristic value will be discussed below.

[27]

Firstly, the amplitude characteristic value A[n] of processing frame n is the value of the mean square of the audio signals in frame n and obtained by means of formula (1) below.

[28]

[Equation 1]

$$A[n] = \frac{1}{M} \sum_{m=0}^{M-1} S^2[m + nM] \quad (1)$$

[29]

The vector of the amplitude characteristic value obtained for all the frames of the CM section is expressed by A = (A[0], A[1], ..., A[N-1]).

[30]

The spectrum characteristic value F[k; n] of processing frame n is the average spectrum in frame n and obtained by means of formula (2) below;

[31]

[Equation 2]

$$F[k;n] = \left| \sum_{m=0}^{M-1} S[m] e^{-2\pi jmk/M} \right|^2 \quad (2),$$

[32]

where k = 0, ..., K, representing the discretized frequency, K being the maximum frequency to be treated. The computation is carried out by typically using FFT or linear prediction analysis. The operation of discretization of frequency can be reduced to a linear one or non-linear one that uses octave as unit of operation by rediscretizing k in formula (2). The vector of the spectrum characteristic value obtained for all the frames of the CM section is expressed by F = (F[0;0], F[1;0], ..., F[K-1;N-1]).

[33]

The linear prediction coefficient P[k;n] of processing frame n can be computationally determined by using an LPC algorithm such as the one shown in Linear Prediction of Speech (Markel et al., Springer Verag, 1978). k = 0, ..., K-1denotes the number for the linear prediction coefficient and K denotes the degree of prediction. The vector of the linear prediction coefficient obtained for all the frames of the CM section is expressed by P = (P[0;0], P[1;0], ..., P[K-1;N-1]).

[34]

The luminance histogram $H_l[q;n]$ of processing frame n is the luminance histogram of the video signals of frame n. q = 0, ..., Q-1 denotes the index number of the luminance slot and Q denotes the number of slots of the histogram.

[35]

The color histogram $H_c[q;n]$ of processing frame n is the intensity histogram of each color of the signal of frame n. q = 0, ..., Q-1 denotes the index number of the color and intensity slot and Q denotes the number of slots of the histogram.

[36]

The vector of the luminance histogram and that of the color histogram formed for all the frames of the CM section are expressed respectively by H_l =

($H_l[0;0]$, $H_l[1;0]$, ..., $H_l[Q-1;N-1]$) and $H_c = (H_c[0;0], H_c[1;0], ..., H_c[Q-1;N-1])$.

[37]

The average luminance B[n] of processing frame n is that of the video signals in processing frame n and determined by formula (3) below.

[38]

[Equation 3]

$$B[n] = \frac{1}{XYL}\sum_{l=0}^{L-1}\sum_{x=0}^{X-1}\sum_{y=0}^{Y-1} I[x, y; l] \quad (3)$$

[39]

The vector of the average luminance B[n] obtained for all the frames of the CM section is expressed by $B = (B[0], B[1], ..., B[N-1])$.

[40]

The luminance difference energy D[n] of processing frame n is the inter-pixel difference energy of adjacent video frames and typically determined by formula (4) below.

[41]

[Equation 4]

$$D[n] = \frac{1}{XY(L-1)}\sum_{l=1}^{L-1}\sum_{x=0}^{X-1}\sum_{y=0}^{Y-1}\left(I[x, y; l] - I[x, y; l-1]\right)^2 \quad (4)$$

[42]

The vector of the luminance difference energy obtained for all the frames of the CM section is expressed by D = (D[0], D[1], ..., D[N-1]). The inter-pixel difference may be replaced by the difference in the average luminance of all the images or the inter-block difference, using blocks of 8 × 8 pixels or 16 × 16 pixels for horizontal direction × vertical direction.

[43]

The number of cut changes C[n] of processing frame n is the number of the frames where the pixel difference energy between adjacent video frames exceeds a predetermined threshold value in the processing frame n and determined by formula (5) below;

[44]

[Equation 5]

$$C[n] = Count_{l=1}^{L-1}\left(\sum_{x=0}^{X-1}\sum_{y=0}^{Y-1}\left(I[x,y;l]-I[x,y;l-1]\right)^2 \geq D_{thsd}\right) \quad (5)$$

[45]

where $Count^b_a$ (f) is a function for showing the number of times where the requirement of evaluation formula f is satisfied and D_{thsd} is a predetermined threshold value for the luminance difference energy. The vector of the number of cut changes obtained for all the frames of the CM section is expressed by C = (C[0], C[1], ..., C[N-1]).

[46]

The time of each cut change can be determined in terms of frame number n that satisfies the requirement of C[n] > 0. The number of cut changes for all the CM section can be determined as the total sum of C[n].

[47]

The CM characteristics extracting section 203 detects all or part of the above described characteristic values for each CM section. Therefore, the characteristic values that characterizes the CM section is expressed by vector V defined by formula (6) below.

[48]

$$V = (A, F, P, H_l, H_c, B, D, C) \quad (6)$$

The characteristic vector V can also be defined by formula (7) below;

[49]

$$V = (V[0], V[1], ..., V[N-1]) \quad (7)$$

where V[n] is the vector of the characteristic values of processing frame n and defined by formula (8) below.

[50]

$$V = (A[n], F[k;n], P[k;n], H_l[n], H_c[n], B[n], D[n], C[n]) \quad (8)$$

The characteristic values described above and extracted by the CM characteristics extracting section 203 are then stored in the CM recording section

205 with the signal of the CM section (including video signal/audio signal/control signal/program guide signal) for the CM section extracted by the CM extracting section 201, which is described earlier.

[51]

FIG. 5 is a schematic block diagram of a subset of the embodiment including the CM extracting section 201, the CM detecting section 202, the CM characteristics extracting section 203 and the CM recording section 205 and FIG. 6 is a flow chart of the operation of the subset of FIG. 5. Note that the steps of the flow chart of FIG. 6 that are same as those of the flow chart of FIG. 3 are denoted respectively by the same step numbers and will not be described any further. Therefore, only the steps relating to the CM characteristics extracting section 203 will be described below.

[52]

Referring to FIG. 6 illustrating the operation of the subset of FIG. 5, after Step S220, where the video signal, the audio signal, the control signal and the program guide signal of the input signal 200a are sequentially input, the processing operation proceeds to Step S231, where the input signal 200a is temporarily stored in the internal or external temporary storage of the CM characteristics extracting section 203.

[53]

At the same time, the start time of the CM section and the time length of the CM section are detected by the CM detecting section 202 and the processing operation proceeds to Step S233 if it is determined in Step S222 that the detected section is a CM section, whereas the processing operation proceeds to Step S235 if it is determined in Step S222 that the detected section is not a CM section.

[54]

As for the subset of FIG. 5, as the processing operation proceeds to Step S232, the CM characteristics extracting section 203 extracts characteristic values of the CM section out of the video signal, the audio signal, the control signal and the program guide signal of the CM section and the extracted characteristic values are stored in the CM recording section 205 in Step S234.

[55]

Then, the processing operation proceeds to Step S235, where the signals temporarily stored in the CM characteristics extracting section 203 are discarded, and returns to Step S220 to repeats the above steps.

[56]

Returning to FIG. 1, the CM part signals 201a (including the video signals, the audio signals, the control signals and the program guide signals) of the CM section stored in the CM recording section 205 and the characteristic values 203a of the CM section are read out of the CM recording section 205 and sent to the CM

index generating section 206 and the CM viewing section 208.

[57]

The CM index generating section 206 generates information to be used as indexes for the CM on the basis of the CM part signals 201a and the characteristic values 203a fed from the CM recording section 205 and sends the information 206a (to be referred to as CM index information hereinafter) to the CM viewing section 208.

[58]

The CM index information 206 a may typically be information showing the starting image, the cut point image, the cut point video image, the starting sound and/or the ending sound of the CM, which will be described below.

[59]

Now, the CM index information 206a will be discussed below.

[60]

Firstly, the starting point image is the image at the very start of the CM section and used as part of the index information.

[61]

The cut point image is the image of a cut point of the CM section and used as part of the index information. Since a cut point belongs to a processing frame whose characteristic value C[n] is greater than 0, the image of the time is used.

While a CM section normally has a plurality of cut points, only a single image that may be the image of the first cut point or that of the last cut point as selected according to a predetermined criterion is used as the cut point image.

[62]

The cut point video image is obtained by connecting the images of the cut points of the CM section to produce a video image, which is then used as part of the index information. Since a CM section normally has a plurality of cut points, a short video image is generated by connecting all the images of all the cut points.

[63]

The starting sound is a sound that lasts for a predetermined period of time, e. g., 2 seconds, from the very start of the CM section and used as part of the index information. Since CMs often have a short characteristic sound at the very start thereof, it is useful to utilize the starting sound as a CM index.

[64]

The ending sound is a sound that lasts for a predetermined period of time, e. g., 2 seconds, until the very end of the CM section and used as part of the index information. Since CMs often have a sound and an image specific to a particular product or a particular company or some other organization, it is useful to utilize the ending sound as a CM index.

[65]

The CM part signals 201a and the characteristic values 203a of the CM section from the CM recording section 205 (to be collectively referred to as recording section reproduced signal 205a whenever appropriate hereinafter) are supplied to the CM viewing section 208 along with the CM index information 206a from the CM index generating section 206. The CM viewing section 208 includes a display processor 801 and a display section 802.

[66]

The display section 802 typically comprises a display device such as a CRT (cathode ray tube) or a liquid crystal monitor and a loudspeaker and is adapted to provide the user with images and sounds.

[67]

The display processor 801 of the CM viewing section 208 is also fed with the user selected information 207a generated by the CM selecting section 207 according to the selecting instruction 209a of the user 209. As will be described hereinafter, the user 209 will view (208a) the CM index images, or the images and the icons, displayed on the display section 802 and issues a selecting instruction 209a to the CM index images, or the images and the icons, displayed on the display section 802 typically by means of a pointing device which may be a mouse, a remote commander or a touch panel. Then, the CM selecting section 207 generates user selection information 207a corresponding to the user's selecting

instruction 209a. The generated user selection information 207a is sent to the display processor 801 of the CM viewing section 208.

[68]

The display processor 801 receives the CM index information 206a and the recording section reproduced signal 205a (particularly, video/audio signal sections) along with the user selection information 207a from the CM selecting section 207 and operates to display information to the user. The display processor 801 may typically comprise a processor and software.

[69]

Now, the operation of the display processor 801 will be discussed below by referring to FIG. 7 showing a typical image of the display section 802.

[70]

The display processor 801 firstly arranges CM index images, or video images 810, on a plurality of CMs according to the CM index information 206a typically as a single scene and displays it on the display section 802 as shown in FIG. 7. Each of the CM index images, or the video images 810, may be the starting point image or the cut point video image of the corresponding CM. If the number of CMs (the CM index images or the video images 810) is large, they may be arranged in two or more than two scenes. The display processor 801 also arranges icons 811 through 814 to be used by the user to input his or her

instructions to the CM selecting section 207 in a scene along with the CM index images or the video images 810 on the display section 802. In the instance of FIG. 7, a total of twelve CM index images or the video images 810 are displayed in a single scene along with a CM reproduction icon 811, a sound reproduction icon 812, a preceding page icon 813 and a succeeding page icon 814.

[71]

When a scene as shown in FIG. 7 is displayed and the display processor 801 receives user selection information 207a from the CM selecting section 207, the display processor 801 changes the display according to the user selection information 207a. More specifically, if the user 209 selects one or more than one CM index images or the video images by way of the CM selecting section 207, the display processor 801 may highlight the selected CM index images or the video images 810.

[72]

Additionally, when a scene as shown in FIG. 7 is displayed and the user 209 selects one of the icons by way of the CM selecting section 207, the display processor 801 carries out a processing operation that corresponds to the selected icon. If, for example, the CM reproduction icon 811 is selected by the user selection information 207a, the display processor 801 reproduces the image and the sound of the CM that is already selected from the CM index images or the video

images 810. If the sound reproduction icon 812 is specifically selected by the user selection information 207a, the display processor 801 reproduces the starting sound, the ending sound or the entire sound of the CM. If the preceding page icon 813 is selected by the user selection information 207a, the display processor 801 displays the CM index images or the video images 810 of the immediately preceding page on the display screen. If, on the other hand, the succeeding page icon 814 is selected by the user selection information 207a, the display processor 801 displays the CM index images or the video images 810 of the immediately succeeding page (that are not viewed by the user) on the display screen.

[73]

FIG. 8 is a schematic block diagram of a subset of the embodiment including the CM recording section 205, the CM index generating section 206, the CM viewing section 208 and the CM selecting section 207. FIG. 9 is a flow chart of the operation of the subset of FIG. 8, that of the CM viewing section 208 in particular.

[74]

Referring to FIG. 9, the CM viewing section 208 specifies the CMs of the first page in Step S240 and obtains the video signals/audio signals of the CMs of the first page in Step S241. Then, CM index information 206a is generated in Step S242 by the CM index generating section 206.

[75]

Subsequently, in Step S243, the display processor 801 of the CM viewing section 208 generates a scene to be displayed on the display screen according to the CM index information 206a and drives the display section 802 to display the scene. Then, in Step S244, the display processor 801 waits for the input of a user instruction (user selection information 207a), while displaying the scene.

[76]

If the user selection information 207a generated by the CM selecting section 207 according to the input of the instruction of the user 209 specifies a CM index, the display processor 801 selects the CM index image or the video image 810 specified by the user selecting information 207a in Step S245. Then, the display processor 801 regenerates the scene highlighting the CM index image or the video image 810 and causes the display section 802 to display the highlighted scene as in Step S243 and subsequently waits for the input of an instruction by the user 209 as in Step S244.

[77]

If the user selection information 207a specifies the CM reproduction icon 811, the display processor 801 reproduces in the CM recording section 205, the video signal and the audio signal of the CM corresponding to the CM index image or the video image 810 already specified by the user selection information 207a, in

Step S246. Then, the display processor 801 regenerates the scene corresponding to the reproduced video signal and causes the display section 802 to display the scene as in Step S243 and subsequently waits for the input of an instruction by the user 209 as in Step S244.

[78]

If the user selection information 207a specifies the sound reproduction icon 812, the display processor 801 reproduces in the CM recording section 205, the audio signal of the starting sound, the ending sound or all the sound of the CM corresponding to the CM index image or the video image 810 already specified by the user selection information 207a, in Step S247. Then, the display processor 801 drives the loudspeaker to output the sound of the reproduced audio signal as in Step S243 and subsequently waits for the input of an instruction by the user 209 as in Step S244.

[79]

If the user selection information 207a specifies the preceding page icon 813, the display processor 801 reproduces in the CM recording section 205, the video signals and the audio signals of the CMs corresponding to the CM index images or the video images 810 of the immediately preceding page, in Step S248. Then, the display processor 801 drives the display section 802 to display the images corresponding to the reproduced video signals as in Step S243 and subsequently

waits for the input of an instruction by the user 209 as in Step S244.

[80]

Finally, if the user selection information 207a specifies the succeeding page icon 814, the display processor 801 reproduces in the CM recording section 205, the video signals and the audio signals of the CMs corresponding to the CM index images or the video images 810 of the immediately succeeding page, in Step S249. Then, the display processor 801 drives the display section 802 to display the images corresponding to the reproduced video signals as in Step S243 and subsequently waits for the input of an instruction by the user 209 as in Step S244.

[81]

The above steps will then be repeated appropriately.

[82]

Returning to FIG. 1, the characteristic vector V of each CM recorded in the CM recording section 205 is sent to the characteristics comparing section 204 as signal 205b.

[83]

The characteristics comparing section 204 reads out the characteristic vector V of each CM recorded in the CM recording section 205 by means of a reading control signal 204a. The characteristics comparing section 204 determines by comparison if the CM is the right CM or not by means of the

characteristic vector V_i of the CM read out from the CM recording section 205. Note that "i" denotes the index (the variable of index) discriminating the individual CMs. The characteristics comparing section 204 compares the characteristic vectors V_i and V_j of two CMs in a manner as shown below.

[84]

Firstly, it carries out computations for an evaluation function J(i,j), using formula (9) below.

[85]

[Equation 6]

$$J(i;j) = \left|V_i - V_j\right|^2 = \sum_{n=0}^{N-1} \left|V_i[n] - V_j[n]\right|^2 \quad (9)$$

[86]

Subsequently, it compares J(i,j) with a predetermined threshold value J_{thsd} and determines to be same if J(i,j) is lower than J_{thsd} and to be different if J(i,j) is not lower than J_{thsd}. The characteristics comparing section 204 carries out the comparing operation for all the CMs stored in the CM recording section 205 and removes either one of the two CMs that are determined to be same from the CM recording section 205. As a result, all the duplicate signals of CMs stored in the CM recording section 205 will be removed.

[87]

FIG. 10 is a schematic block diagram of a subset of the embodiment including the CM recording section 205 and the characteristics comparing section. FIG. 11 is a flow chart of the operation of the subset of FIG. 10, that of the characteristics comparing section 204 in particular.

[88]

Referring to FIG. 11, the characteristics comparing section 204 sets the variable i of said index to 0 in Step S250 and then sets the variable j of said index to i+1.

[89]

Subsequently, the characteristics comparing section 204 carries out computations for the evaluation function J(i,j) on the basis of the characteristic vectors V_i and V_j and compares it with a predetermined threshold value J_{thsd} in Step S252. If the value of the function J(i,j) is lower than the threshold value J_{thsd} (Yes), the two CMs are determined to be same and the CM represented by the characteristic vector V_j is removed from the CM recording section 205 in Step S253. If, on the other hand, the value of the function J(i,j) is not lower than J_{thsd} (No), the two CMs are determined to be different from each other and the processing operation proceeds to Step S254.

[90]

As the processing operation proceeds to Step S254, the characteristics

comparing section 204 checks if the value of j corresponds to the last CM number among the CMs to be compared or not. If it is determined in Step S254 that the value of j does not correspond to the last CM member (No), j is incremented in Step S255 and the processing operation returns to Step S252, where J(i,j) is compared with the threshold value once again. If, on the other hand, it is determined in Step S254 that the value of j corresponds to that last CM member (Yes), it is determined in Step S256 if i corresponds to the last CM number or not. If it is determined in Step S256 that the value of i does not correspond to the last CM number (No), i is incremented in Step S257 and the processing operation returns to Step S251 to set j once again. If, on the other hand, it is determined in Step S256 that the value of i corresponds to the last CM number (Yes), the processing operation is terminated there.

[91]

In this embodiment of broadcast signal processing device, additionally retrieval icons may be added to the displayed scene of the display section 802 illustrated in FIG. 7 so that the CM wanted by the user may be retrieved by specifying the corresponding retrieval icon. FIG. 12 schematically illustrates a scene displayed on the display section 802 and containing an additional retrieval icon 815. The operations of the CM recording section 205, the characteristics comparing section 204, the CM viewing section 208, the CM index generating

section 206 and the CM selecting section 207 will be described by referring to the illustrated image of FIG. 12.

[92]

As the retrieval icon 815 is specified by the user 209, the CM selecting section 207 generates user selection information 207a corresponding to the user's selection and transmits the user selection information 207a to both the CM viewing section 208 and the characteristics comparing section 204.

[93]

Upon receiving the user selection information 207a, the characteristics comparing section 204 retrieves the CM having characteristics whose values partially agree with those of the CM that is already selected in the CM index image or the video image 810.

[94]

More specifically, when a CMi is selected by the CM selecting section 207 according to the user selection information 207a, the characteristics comparing section 204 compares the characteristic values of the CMi with the characteristic values of the CMj that is recorded in the CM recording section 205.

[95]

For carrying out this comparing operation, the characteristics comparing section 204 firstly carries out computations for the evaluation function J'(i,j) of the

CM part section, using formula (10) below;

[96]

[Equation 7]

$$J'(i,j) = \sum_{n=N_s}^{N_e} \left| V_i[n] - V_j[n] \right|^2 \qquad (10)$$

[97]

where N_s denotes the first processing frame number of the CM part section to be compared and N_e denotes the last processing frame number of the CM part section to be compared.

[98]

Subsequently, the characteristics comparing section 204 compares the evaluation function J'(i,j) with the predetermined threshold value J'_{thsd} and determines that they do not agree with each other when the former is greater than the latter value but they do when the former is not greater than the latter.

[99]

It should be noted here that different CMs provided by a same sponsor may often be so designed as to make the viewer have a feeling of sameness or similarity by using common video/audio signals that are specific to a particular product or a particular company or some other organization. Then, the common video/audio signals will normally last for about a second. Therefore, if N_e = N-1 is used for

the last frame number of the CM section and N_s is used for the processing frame preceding the last frame by one second, all the CMs provided by a same company can be retrieved by specifying one of the CMs of the company.

[100]

The evaluation function J'(i,j) to be used for comparing characteristics values may alternatively be defined by formula (11) below;

[101]

[Equation 8]

$$J'(i,j) = Min_s \sum_{n=sN_\omega}^{(s+1)N_\omega} \left| V_i[n] - V_j[n] \right|^2 \qquad (11)$$

[102]

where N_w denotes the span to be used for retrieving agreeing parts whose characteristic values agree with each other and s denotes the index number that is used for shifting the span for retrieving partially agreeing parts from the beginning to the end of the CM section. Min_s () denotes the smallest value of all the values of s. It will be effective to use only the sound-related characteristic values A[n], F[k;n] and P[k;n] excluding the image-related characteristic values $H_l[n]$, $H_c[n]$, B[n], D[n] and C[n] from the vector [n].

[103]

By using such a function, it is possible to retrieve CMs that partly agree

with each other. For example, CMs containing a same piece of background music may be retrieved. If the CMs of a particular product or a particular company or some other organization are designed to provide a sense of continuation, they are often made to contain a same piece of background music in order to make the viewers have a feeling of sameness of similarity. Therefore, the function can be an effective evaluation function to be used for retrieving CMs that are designed to provide a sense of continuation.

[104]

The evaluation functions J(i,j) and J'(i,j) may be referred to as similarity of two CMs.

[105]

The audio and video signals of the CM retrieved from the CM recording section 205 are then sent to the CM viewing section 208 as recording section reproduced signal 205a.

[106]

At the same time, the index generating section 206 generates index information on the CMs whose characteristic values agree with each other and transmits the generated index information 206a to the CM viewing section 208.

[107]

As a result, the CM viewing section 208 can display the image of the

retrieved CM and/or reproduce the sound of the CM.

[108]

FIG. 13 is a schematic block diagram of a subset of the embodiment including the CM recording section 205, the characteristics comparing section 204, the CM index generating section 206, the CM viewing section 208 and the CM selecting section 207. FIG. 14 is a flow chart of the operation of the subset of FIG. 13. It will be appreciated that the flow chart of FIG. 14 comes immediately after the flow chart of FIG. 9.

[109]

Referring to FIG. 14, when the processing operation waits for a user's instruction in Step S244 in the flow chart of FIG. 9 and the user selection information 207a specifies the CM retrieval icon 815, the characteristic comparing section 204 sets the index variable i to the value of the index of the selected CM in Step S260 and then sets the index variable j to 0 in Step S261.

[110]

Subsequently, the characteristics comparing section 204 carries out computations for the evaluation function J'(i,j) in Step S262, using the characteristic vectors V_i and V_j, and compares the obtained value with the predetermined threshold value J'_{thsd}. If it is determined that the obtained value is not greater than the threshold value J'_{thsd} (Yes), the CM is judged to be a similar

CM and the CM represented by the characteristic vector V_j is marked in Step S263. If, on the other hand, it is determined that the obtained value is greater than the threshold value J'_{thsd} (No), the CM is judged to be not a similar CM and the processing operation proceeds to the next step, or Step S294.

[111]

In Step S294, the characteristics comparing section 204 checks if the value of j corresponds to the last CM number among the CMs to be compared or not. If it is determined in Step S294 that the value of j does not correspond to the last CM member (No), j is incremented in Step S265 and the processing operation returns to Step S262, where J(i,j) is compared with the threshold value once again. If, on the other hand, it is determined in Step S266 that the value of j corresponds to that last CM member (Yes), all the marked CMs are specified collectively and the processing operation returns to Step S241 shown in FIG. 9, where signals of the specified CMs are retrieved from the CM recording section 205.

[112]

This embodiment may alternatively be so arranged that the same CMs are not removed but stored and, the number of times and the clock times when same CMs are broadcast by retrieving them, detecting the agreement in all the CM sections.

[113]

As will be appreciated from the above description, with this embodiment of broadcast signal processing device, only the CM sections can be extracted from a broadcast signal and stored. Therefore, it is possible to provide a data base device adapted to store only the CM sections of a program without recording the program itself.

[114]

Additionally, with this embodiment of broadcast signal processing device, only the CM sections can be extracted from a broadcast signal along with characteristic values characterizing the CM sections so that the characteristic values may be stored. Then, it is possible to provide a data base device adapted to store only the CM sections of a program and their characteristic values without recording the program itself. Such characteristic values are useful when retrieving same CMs and/or similar CMs.

[115]

Still additionally, with this embodiment of broadcast signal processing device, any of the stored CMs can be displayed and viewed so that the viewer (user) can display a list of the stored CMs and reproduce and retrieve any CMs he or she wants. This functional feature is particularly useful when the viewer wants to detect and view a specific CM.

[116]

Still additionally, with this embodiment of broadcast signal processing device, any duplicate CMs can be removed from the stored CMs to save the storage capacity and eliminate the trouble of repeatedly viewing same CMs.

[117]

Furthermore, with this embodiment of broadcast signal processing device, it is possible to retrieve similar CMs so that the CMs of a same product and the CMs of a same provider can be retrieved and displayed with ease.

[118]

Furthermore with this embodiment of broadcast signal processing device, it is possible to retrieve CMs having a same end part. Because CMs of a same product or a same company or some other organization normally contains a common image and a common sound, it is now possible to retrieve the CMs of a same product or a same provider can be retrieved and displayed with ease.

[119]

Still furthermore, with this embodiment of broadcast signal processing device, it is now possible to retrieve CMs containing a common piece of background music. Because CMs of a same product or a same company or some other organization often contains a common piece of background music, different CMs prepared with a sense of continuity can be retrieved and displayed without difficulty.

[120]

Finally, with this embodiment of broadcast signal processing device, it is possible to observe the number of times and the clock times when same CMs are broadcast. This functional feature can be of great help to the producer of a CM when he or she compares each scheduled transmission of the CM and the corresponding actual transmission of the CM.

[121]

Now, the operation of the CM detecting section 202 of FIG. 1 for detecting CMs out of a broadcast signal along with the start time and the length of each CM will be discussed below in greater detail.

[122]

Firstly, the principle underlying the operation of detecting a CM section out of a TV broadcast signal of the CM detecting section 202 will be briefly described. In the following description, while the term "a characteristic value" may or may not mean same as the term "characteristic" as used above from viewpoint of the CM characteristics extracting section 203 and the characteristics comparing section 204, although the both are used to express a characteristic aspect of a CM. Therefore, the two terms are used here indiscriminately.

[123]

Generally, CMs that are broadcast through TV channels are prepared

according to the specifications provided by the broadcasters particularly in terms of duration and hence "the time length (of a CM) is limited and cannot vary in many different ways". For instance, in Japan, all CMs have a duration of 15 seconds, 30 seconds or 60 seconds with very few exceptions.

[124]

Additionally, when a CM is broadcast, it is inserted into the stream of a TV program but prepared independently from the latter so that "the sound level falls (and becomes less audible)" and "the video signal is switched" inevitably before and after the CM. The expression that "the sound level falls" does not necessarily means that silence (or only a light noise) prevails there. In other words, the program can be switched to the CM or vice versa without a complete silence depending on the timing of the switch.

[125]

Almost all CMs show the three characteristic aspects of CMs including "specified time lengths (few variations in time length)", "a low sound level" and "a switched image". In other words, these are three "requirements" to be met by CMs. Therefore, these requirements will be referred to as "the three indispensable requirements" of CMs hereinafter.

[126]

Thus, it is deterministically possible to detect CM candidates (or signal

parts that will probably represents the corresponding respective CMs) practically without error by detecting the signal parts that meets the indispensable requirements out of a TV broadcast signal. However, since programs can also contain signal parts that do not represent any CM but meet the indispensable requirements, there still remains a risk of erroneously detecting parts of the program as CM candidates if only the indispensable requirements are used for detecting CMs.

[127]

On the other hand, many CMs show some or all of the following characteristic aspects due to of the nature of CMs, although there are obviously more exceptions if compared with the indispensable requirements.

[128]

1) The sound level can be more often than not falls immediately before and after a CM (immediately before the start of a CM and immediately after the end of the CM and before the restart of the program itself).

[129]

2) A silence of several hundred milliseconds can often appear between a CM and the program containing the CM or between a CM and another CM.

[130]

3) The sounded sections of a TV program normally have a length shorter than

the specified durations of CMs (15 seconds, 30 seconds, 60 seconds) by more than about hundred milliseconds and less than about a second.

[131]

4) The correlative value of the left channel (L-channel) and the right channel (R-channel) of a stereophonic sound signal is more often than not significantly smaller than 1.

[132]

5) The sound level of CMs is often higher than that of programs.

[133]

6) CMs are often broadcast in a stereophonic mode

[134]

7) A plurality of CMs are often broadcast in a CM section.

[135]

8) More video cuts are used per unit time in CMs than in programs.

[136]

9) To the contrary, there are CMs containing extremely small video cuts per unit time (e.g., CMs using still images).

[137]

10) The sound quality can remarkably change at the boundary of a program and a CM or that of two CMs.

[138]

11) CMs often contain both voices and music.

[139]

12) CMs are broadcast with a high probability on the hour.

[140]

13) Similarly, CMs are broadcast with a high probability on the half hour.

[141]

14) There are time slots where CMs are broadcast highly probably depending on the program category (e.g., during the half time of the live of a succor match)

[142]

For the purpose of the present invention, the requirements that arises from the above characteristic aspects of CMs will be referred to as "additional requirements". In other words, the additional requirements occurs from the fact that CMs are produced by conforming to given specifications, that CMs are intended to achieve an advertising effect in a very short period of time and that CMs are subject to programming restrictions. Therefore, while the additional requirements are not deterministically reliable, they are effective when evaluating the probability of each CM.

[143]

In TV broadcasts, the images and sounds of two or more than two channels will never be transmitted through a single channel. In other words, if two video and audio sections that satisfy the above additional requirements are found in a TV broadcast signal and are overlapping each other and CM candidates are detected in such partly overlapping sections when detecting signal parts (CM candidates) from a TV broadcast signal, either of the overlapping video and sound sections cannot represent a right CM section. For the purpose of the invention, this requirement of TV broadcasts is referred to as "logical requirement".

[144]

Thus, for the purpose of the invention, the above described "indispensable requirements", "logical requirement" and "additional requirements" are rationally and effectively utilized to accurately detect CM sections from a TV broadcast signal.

[145]

More specifically, according to the invention, CM candidates (signal parts that probably represent respective CMs) are deterministically extracted from a TV broadcast signal on the basis of the "indispensable requirements" and selected according to statistic criteria that are based on the "additional requirements and any overlapping relationship of CMs is eliminated on the basis of the "logical requirement" to accurately detect CMs.

[146]

FIG. 15 is a schematic block diagram of the CM detecting section, illustrating a possible first configuration thereof. Roughly speaking, the CM detecting section 202 comprises a front end section and a rear end section. In FIG. 15, the operation control section 23 determines if the broadcasting channel being detected is a channel where CMs are broadcast or not on the basis of channel information 1b that indicates the type of the channel and controls the components of FIG. 15 so as not to operate for detecting CMs if the channel is not used for broadcasting CMs.

[147]

Firstly, the front end section of FIG. 15 will be described.

[148]

Referring to FIG. 15, the video signal 2a, the audio signal 2b and the broadcasting mode signal 2c of the input signal 200a are input to the front end section. The time information 3a generated by a clock (not shown) is also fed to the front end section.

[149]

The video signal 2a is digitized by A/D converter 10 and stored in frame memory 11, which is adapted to store at least video signals for two frames. The video signal read out from the frame memory 11 for each frame is then sent to cut

change detector 12.

[150]

The cut change detector 12 detects frames where the image changes abruptly (to be referred to as image change frames hereinafter) and frames showing a uniform luminance (to be referred to as uniform luminance frames hereinafter) on the basis of the video signal of each frame fed from the frame memory 11.

[151]

More specifically, the cut change detector 12 determines the difference of the square sums of the pixels of the temporally adjacent frames stored in the frame memory 11 and detects the temporally succeeding one of the two adjacent frames as image change frame where the image changes abruptly if the difference of the square sums exceeds a predetermined threshold value. Additionally, the cut change detector 12 determines the variance of luminance of the image of each of the frames stored in the frame memory 11 and detects the frame as a uniform luminance frame if the variance of luminance of the frame is under a predetermined threshold value. If the time interval separating two adjacent frames (about 30ms in the case of the NTSC system) does not agree with the frame period in the audio signal processing operation which will be described hereinafter, it is made to agree with the frame period by rediscretizing the time interval of two adjacent frames.

[152]

Now, the operation of detecting image change frames and uniform luminance frames of the cut change detector 12 will be described below in greater detail.

[153]

Assume that the transversal size and the longitudinal size of a discretized video signal are X and Y respectively, that the transversal and longitudinal pixel numbers of each pixel are expressed by x, y respectively and that the image of the n-th frame is expressed by $I_n(x,y)$ while the image of the (n-1)-th frame that temporally immediately precedes the n-th frame is expressed by $I_{n-1}(x,y)$. Then, the square sum D[n] of the difference of luminance of the pixels between the n-th frame and the (n-1)-th frame is obtained by formula (12) below and the variance of luminance of the n-th frame V[n] is expressed by formula (13) below.

[154]

[Equation 9]

$$D[n] = \sum_{x=0}^{X-1}\sum_{y=0}^{Y-1}\left(I_n(x,y) - I_{n-1}(x,y)\right)^2 \qquad (12)$$

$$V[n] = \frac{1}{XY}\sum_{x=0}^{X-1}\sum_{y=0}^{Y-1} I_n^2(x,y) - \left(\frac{1}{XY}\sum_{x=0}^{X-1}\sum_{y=0}^{Y-1} I_n(x,y)\right)^2 \qquad (13)$$

[155]

The detection output C[n] of the cut change detector 12 is expressed by

formula (14) below;

[156]

[Equation 10]

$$C[n] = \begin{cases} 1\left(D[n] \geq D_{thsd}\ or V[n] \leq V_{thsd}\right) \\ 0\left(D[n] < D_{thsd}\ and V[n] > V_{thsd}\right) \end{cases} \quad (14)$$

[157]

where D_{thsd} is the predetermined threshold value for the square sum that is used when detecting an image change frame and V_{thsd} is the predetermined threshold value for the variance of luminance that is used when detecting a uniform luminance frame.

[158]

The detection output C[n] of the cut change detector 12 is then sent to characteristic value buffer 18 as a characteristic value of the video signal.

[159]

When determining the difference of luminance between the two frame images, a memory having a storage capacity for storing video signals of two frames is required and the detector 12 is required to carry out arithmetic operations on the video signals of two frames. However, the storage capacity and the amount of arithmetic operations can be reduced by dividing a frame image into small blocks and determining the difference of luminance for each block instead of treating the

entire frame image at a same time. Alternatively, they can be reduced by determining the luminance histogram of each frame and subsequently the difference in the luminance histogram between two frames instead of determining the difference of luminance for each pixel. Still alternatively, they can be reduced by determining the average luminance for each frame image and subsequently the difference in the average luminance between two frames. To the contrary, if the storage capacity and the amount of arithmetic operations do not exceed respective permissible levels, the accuracy of detection can be improved by determining the difference of luminance and that of color histogram for individual component colors such as R (red), G (green) and B (blue).

[160]

Meanwhile, the audio signal 2b is digitized by A/D converter 13 and stored in audio signal buffer 14. The audio signal buffer 14 has a storage capacity for storing at least 2-channel stereophonic audio signals for left (L) and right (R) for a predetermined time period T_1 (e.g., 30ms, which is to be referred to as a frame length hereinafter). The audio signals read out from the audio signal buffer 14 are then sent to amplitude detector 15, correlation detector 16 and spectrum detector 17

[161]

The amplitude detector 15 detects the mean square amplitude of a predetermined short period of time T_2 (e.g., 15ms, which is to be referred to as a

frame period hereinafter) from the audio signals stored in the audio signal buffer 14. More specifically, if the audio signal buffer 14 stores 2-channel stereophonic audio signals for left and right, the amplitude detector 15 detects the short period mean square amplitude of each predetermined time period T_2 (15ms, 1 frame period) from the 2-channel stereophonic audio signals $S_L[m]$ and $S_R[m]$. Note that m (m = 0, ..., M-1) represents the sample number in the buffer, showing a discretized time period, and the largest number M corresponds to a frame length T_1.

[162]

More specifically, the amplitude detector 15 calculates the mean square amplitude A[n] for the 2-channel audio signals for left and right in the n-th frame by using formula (15) below.

[163]

[Equation 11]

$$A[n] = \frac{1}{4M} \sum_{m=0}^{M-1} \left(S_L[m + nT_2] + S_R[m + nT_2] \right)^2 \qquad (15)$$

[164]

The mean square amplitude A[n] obtained by, or the detection output of, the amplitude detector 15 is then sent to characteristic value buffer 18 as a characteristic value of the audio signal.

[165]

The correlation detector 16 detects the correlation coefficient for the audio signal of each frame prior to the normalization, using the audio signals stored in the audio signal buffer 14 and also the short period energy to be used in the operation of normalization to be carried out downstream. If the audio signal buffer 14 stores 2-channel stereophonic signals for left and right, the correlation detector 16 detects the correlation coefficient for the 2-channel audio signals for left and right for a frame prior to the normalization out of the 2-channel stereophonic signal for left and right read out from the audio signal buffer 14 and also the short period energy to be used in the operation of normalization to be carried out downstream.

[166]

More specifically, the correlation detector 16 calculates the correlation efficient $A_{LR}[n]$ of the 2-channel audio signals for left and right for the n-th frame by using formula (16) below. It also calculates the left channel audio signal energy $A_{LL}[n]$ by using formula (17) and the right channel audio signal energy $A_{RR}[n]$ by using formula (18) as shown below.

[167]

[Equation 12]

$$A_{LR}[n] = \sum_{m=0}^{M-1} S_L[m + nT_2]S_R[m + nT_2] \quad (16)$$

$$A_{LL}[n] = \sum_{m=0}^{M-1} S_L^2[m + nT_2] \quad (17)$$

$$A_{RR}[n] = \sum_{m=0}^{M-1} S_R^2[m + nT_2] \quad (18)$$

[168]

The detection output of the correlation detector 16 including the correlation coefficient $A_{LR}[n]$, the left channel audio signal energy $A_{LL}[n]$ and the right channel audio signal energy $A_{RR}[n]$ are sent to the characteristic value buffer 18 as so many characteristic values.

[169]

The spectrum detector 17 calculates the short period spectrum by using the audio signals stored in the audio signal buffer 14. If the audio signal buffer 14 stores 1-channel stereophonic audio signals for left and right, the spectrum detector 17 calculates the short period spectrum out of the 2-channel stereophonic audio signals $S_L[m]$ and $S_R[m]$ for left and right read out from the audio signal buffer 14.

[170]

More specifically, the spectrum detector 17 determines the discrete spectrum F[k;n] of the 2-channel audio signals for left and right of the n-th frame. If k = 0, ..., K-1 represents the discretized frequency, the discrete spectrum F[k;n] is expressed by formula (19) below.

[171]

[Equation 13]

$$F[k;n]=\left|\sum_{m=0}^{M-1}\left(S_L[m]+S_R[m]\right)e^{-2\pi jmk/M}\right|^2 \qquad (19)$$

[172]

The arithmetic operation of formula (19) can be realized typically by means of an appropriate technique such as Fast Fourier Transform (FFT) or linear prediction analysis (LPC).

[173]

The computational output, or the short period discrete spectrum F[k:n] of the spectrum detector 17 is sent to the characteristic value buffer 18 as a characteristic value for the audio signal.

[174]

The broadcasting mode signal 2c is made to show a discretized value that conforms to the above described audio signal processing frame.

[175]

More specifically, the broadcasting mode signal 2c of the n-th frame may be made to show a numerical value B[n] as expressed by formula (20).

[176]

[Equation 14]

$$B[n] = \begin{cases} 0\ (monaural \text{mode}) \\ 1\ (stereophonic\ \text{mode}) \\ 2\ (sound - multiplex\ \text{mode}) \end{cases} \quad (20)$$

[177]

The numerical value B[n] obtained by discretizing the broadcasting mode signal 2c is then sent to the characteristic value buffer 18 as a characteristic value of the TV broadcast signal.

[178]

Similarly, temporal signal 3a is also made to show a discretized numerical value T[n] that conforms to the audio signal processing frame and sent to the characteristic value buffer 18 as a characteristic value.

[179]

Then, the characteristic value buffer 18 stores the characteristic value G[n] shown in formula (21) below that includes the detection output C[n] from the cut change detector 12, the means square amplitude A[n] from the amplitude detector 15, the correlation coefficient $A_{LR}[n]$ and the audio signal energy values $A_{LL}[n]$ and $A_{RR}[n]$ from the correlation detector 16, the short period discrete spectrum F[k;n] from the spectrum detector 17, the discretized numerical value B[n] of the broadcasting mode signal 2c and the discretized numerical value T[n] of the temporal signal 3a for a predetermined period of time T_3. Note that the time T_3 is

so determined that the buffer can store at least a CM and may typically be 80 seconds.

[180]

$$G[n] = \{C[n], A[n], A_{LR}[n], A_{LL}[n], A_{RR}[n], F[k;n], B[n], T[n]\} \quad (21)$$

The front end section of the CM detecting section 202 shown in FIG. 15 comprises the above described components from the A/D converter 10 to the characteristic value buffer 18. Now, the operation of the front end section will be described by referring to the flow charts of FIGS. 16 and 17. Note that Steps S30 through S32 in FIG. 16 are for the video signal 2a, whereas Steps S33 through S40 in FIG. 17 are for the audio signal 2b, the broadcasting mode signal 2c and the temporal signal 3a.

[181]

Firstly, the operation of processing the video signal 2a will be described by referring to FIG. 16. In Step S30, the front end section stores the video signal 2a for at least a frame that is digitized by the A/D converter 10 in the frame memory 11. The frame memory 11 is so designed as to handle a video signal 2a for a frame as a sample. Therefore, as the video signal 2a for a frame is input, the video signals 2a already stored in the frame memory 11 are shifted by a frame and the video signal 2a that was stored first in the frame memory 11 is pushed out as output.

[182]

Next, the front end section reads out the video signal 2a from the frame memory 11 and transmits it to the cut change detector 12 in Step S31, which cut change detector 12 by turn produces the detection output C[n] in a manner as described above.

[183]

Then, the front end section stores the detection output C[n] in the characteristic value buffer 18 in Step S32.

[184]

Now, referring to FIG. 17 showing the operation of processing the audio signal 2b, the front end section inputs the audio signal 2b that is digitized by the A/D converter 13 into the audio signal buffer 14 and stores the audio signal 2b for at least a frame period T_2 in the audio signal buffer 14 in Steps S33 and S34. The audio signal buffer 14 is so designed as to handle an audio signal 2b for a frame period T_2 as a sample. Therefore, as the audio signal 2b for a frame period T_2 is input, the audio signals 2b already stored in the audio signal buffer 14 are shifted by a frame period T_2 and the audio signal 2b for a frame period T_2 that was stored first in the audio signal buffer 14 is pushed out as output.

[185]

As the audio signal buffer 14 stores at least an audio signal 2b for a frame

period T_2, the front end section reads out the audio signal 2b stored in the audio signal buffer 14 and transmits it to the amplitude detector 15 in Step S35, which amplitude detector 15 by turn produces the means square amplitude A[n] in a manner as described above.

[186]

At the same time, the front end section transmits the audio signal 2b stored in the audio signal buffer 14 to the correlation detector 16 in Step S36, which correlation detector 16 by turn produces the correlation coefficient $A_{LR}[n]$ and the audio signal energy values $A_{LL}[n]$, $A_{RR}[n]$ in a manner as described above.

[187]

Concurrently, the front end section transmits the audio signal 2b stored in the audio signal buffer 14 to the spectrum detector 17 in Step S37, which spectrum detector 17 by turn produces the short period discrete spectrum F[k;n] in a manner as described above.

[188]

Furthermore, the front end section determines the discretized numerical value B[n] from the broadcasting mode signal 2c and the discretized numerical value T[n] from the temporal signal 3a in Step S38.

[189]

Then, the front end section stores the characteristic value G[n] including the

detection output C[n] from the cut change detector 12, the root-mean-square amplitude A[n] from the amplitude detector 15, the correlation efficient $A_{LR}[n]$ and the audio signal energy values $A_{LL}[n]$, $A_{RR}[n]$ from the correlation detector 16, the short period discrete spectrum F[k;n] from the spectrum detector 17, the discretized numerical value B[n] of the broadcasting mode signal 2c and the discretized numerical value T[n] of the temporal signal 3a in the characteristic value buffer 18.

[190]

Returning to FIG. 15, now the operation of the band end section will be described below. In the following description, n denotes the frame number of the characteristic value of each frame stored in the characteristic value buffer 18. The characteristic value of the most recent frame is expressed by G[0] and the value of n increases for an older frame so that, when the most recent frame is updated, the numbers of all the other frames and hence those of their characteristic values are shifted by 1).

[191]

Referring to FIG. 15, the characteristic values stored in the characteristic value buffer 18 are sent to CM candidate detector 19 on a frame by frame basis.

[192]

The CM candidate detector 19 computationally detects the CM section, if any, of each frame on the basis of the above described "indispensable

requirements" that are satisfied by almost all CMs. The indispensable requirements include that the audio signal of a CM shows a "low sound level" and hence the sound level of the audio signal is below a predetermined threshold level (to be referred to as sound level requirement hereinafter), that there is a "switched image" and hence the video signal shows an abrupt change or a uniform luminance in a frame (to be referred to as video requirement hereinafter) and that there is a "specified time length (few variations in time length)" and hence the temporal interval of two frames that satisfy both the sound level requirement and the video requirement agrees with the time length of the CM (to be referred to as time requirement hereinafter). More specifically, these requirements can be defined by formulas (22), (23) and (24), using the above described characteristic values;

[193]

$$A[0] < A_{thsd} \quad (22),$$

$$C[0] = 1 \quad (23) \text{ and}$$

$$A[n_1] < A_{thsd}, \quad C[n_1] = 1 \text{ or } A[n_2] < A_{thsd}, C[n_2] = 1 \text{ or}$$

$$A[n_3] < A_{thsd}, C[n_3] = 1 \quad (24)$$

where A_{thsd} is the predetermined threshold value for the square-root amplitude and n_1, n_2 and n_3 are respective numerical values obtained by reducing the time lengths specified as CM lengths (e.g., 15 seconds, 30 seconds and 60 seconds as described above for the purpose of this embodiment) in terms of the unit of frame period.

For the purpose of improving the practical applicability, the numerical values n_1, n_2 and n_3 are allowed to be slightly variable.

[194]

Now, the operation of the CM candidate detector 19 will be described by referring to FIG. 18.

[195]

Referring to FIG. 18, like the frame memory and the audio signal buffer described above respectively by referring to Step S32 in FIG. 16 and Step S40 in FIG. 17, the characteristic value buffer 18 is so designed as to operates for inputting, shifting and outputting signals on the basis of a unit of a frame. In other words, the characteristic value buffer 18 is adapted to handle the characteristic value of a frame as a sample. Therefore, when the characteristic value of a frame is input, all the characteristic values already stored in the characteristic value buffer 18 are shifted by 1 frame and the characteristic value of a frame that was stored first in the characteristic value buffer 18 is pushed out as output.

[196]

As a result of the processing operations of Steps S50 and S51 of inputting the characteristic value of a frame (a sample) from the characteristic value buffer 18, the CM candidate detector 19 checks if the characteristic value of a frame (a sample) meets the indispensable requirements including the sound level

requirement, the video requirement and the time requirement in Steps S52 and S53. More specifically, the CM candidate detector 19 determines if the frame meets the indispensable requirements including the sound level requirement, the video requirement and the time requirement or not by comparing the means square amplitude A[0] of the first frame and the predetermined threshold value A_{thsd} for square-root amplitude in Step S52 and checking if the detection output C[0] is equal to 1 or not in Step S53. If it is determined by the CM candidate detector 19 that the means square amplitude A[0] does not exceed the predetermined threshold value A_{thsd} for square-root amplitude and the indispensable requirements are met as a result of the processing operations of Steps S52 and S53, the frame is selected as CM candidate and the operation proceeds to Step S57 and on (Step S54 through S56 will be described hereinafter). If, on the other hand, it is determined by the CM candidate detector 19 that the means square amplitude A[0] exceeds the predetermined threshold value A_{thsd} for square-root amplitude or the indispensable requirements are not met as a result of the processing operations of Steps S52 and S53, the frame is not selected as CM candidate and the operation returns to Step S50.

[197]

If it is determined that the means square amplitude A[0] does not exceed the predetermined threshold value A_{thsd} for square-root amplitude and the

indispensable requirements are met as a result of the processing operations of Steps S52 and S53, the CM candidate detector 19 retrieves the CM starting frame n_s in Step S57 and also the CM ending frame n_e in Step S58 and then computationally determines the CM starting time T_s in Step S59 and also the CM length W in Step S60.

[198]

After the retrieving and computing operations of Steps S57 through S60, the CM candidate detector 19 refers to the CM candidate table, which will be described hereinafter, in Step S61 and, if it finds a CM candidate whose CM starting time T_s and CM length T_w respectively agree with those of the detected CM candidate, it returns to Steps S54 through 56. If, on the other hand, it does not find any such a CM candidate, it adds the CM candidate as new one and returns to Steps S54 through S56.

[199]

When the processing operations of Steps S54 through S56 are conducted for all the time lengths, the CM candidate detector 19 returns to Step S50 and repeats the above steps for the next input.

[200]

The CM starting frame n_s refers to the frame number of the first frame whose means square amplitude A[n] exceeds the threshold value A_{thsd} for

square-root amplitude as viewed from the frame that meets the time requirements out of the frames expressed by n_1, n_2 and n_3 toward the most recent frame. Similarly, the CM ending frame n_e refers to the frame number of the last frame whose means square amplitude A[n] does not exceed the threshold value A_{thsd} for square-root amplitude as viewed from the 0-th frame toward the older frames. Furthermore, the CM starting time T_s can be obtained by using the formula of $T_s = T[n_s]$ and the number of the CM starting frame n_s. Similarly, the CM length T_w can be obtained by using the formula of $T_w = T[n_e] - T[n_s]$.

[201]

FIG. 19 shows an example that can be used for defining the indispensable requirements. In the row of A[n] in FIG. 19, [o] denotes a frame whose means square amplitude does not exceed the threshold value for square-root amplitude A_{thsd} and [x] denotes a frame whose root-mean-square amplitude exceeds the threshold value for square-root amplitude A_{thsd}. In the illustrated example, A[0], C[0] and $A[n_1]$, $C[n_1]$ meet the requirements and the frame that is found left relative to n_1 and satisfies the requirement of A[n] = x is n_s, whereas the last one of the successive frames found right relative to 0 and satisfy the requirement of A[n] = o is n_e.

[202]

As a result of the above processing operation, the CM candidate detector 19

detects a CM candidate each time the characteristic value of a frame (sample) is input and, if a CM candidate is detected, it enters the candidate into the CM candidate table.

[203]

FIG. 20 shows an example of CM candidate table. Referring to FIG. 20, the CM candidate table contains items including the starting time T_s, the length T_w, the characteristic values Q_1 through Q_{11} as determined by the additional requirement computing unit 20, which will be described hereinafter, and the score R and the result of score judgment Z determined by the additional requirement determiner 21, which will also be described hereinafter. As shown in FIG. 20, only the starting time T_s and the length T_w are written at the stage of the CM candidate table 19a prepared by the CM candidate detector 19. Thus, the CM candidate table is used to describe and manage the starting time T_s and the length T_w obtained by the CM candidate detector 19, the characteristic values Q_1 through Q_{11} computed by the additional requirement computing unit 20 and the score R and the result of score judgment Z determined by the additional requirement determiner 21. The CM candidate table is maintained until the entry is judged to be a CM or not a CM and is output as CM detection output 4a from the rule judging unit 22 if it is judged to be a CM but simply discarded if it is judged to be not a CM.

[204]

The CM candidate table 19a carrying only the starting time T_s and the length T_w as described by the CM is then sent to the additional requirement computing unit 20.

[205]

The additional requirement computing unit 20 extracts the characteristic values Q_1 through Q_{11} from the candidate sections entered to the CM candidate table 19a, referring to the characteristic value buffer 18, in a manner as described below and adds them to the CM candidate table 19a to produce a CM candidate table 20a, which is then output to the additional requirement judging unit 21.

[206]

FIG. 21 schematically illustrates how the characteristic values Q_1 through Q_{11} are computationally determined by the additional requirement computing unit 20.

[207]

Referring to FIG. 21, the horizontal axes represent the frame number (corresponding to the discrete time). In FIG. 21, (a) shows the cut change detection output C[n] and (b) shows the discretized numerical value B[n] of the broadcast mode signal 2c, whereas (c) shows the short period discrete spectrum S[k,n] of the audio signal and (d)shows the root-mean-square amplitude A[n] of the audio signal. The part indicated by n_1 (the part between the dotted lines) in FIG.

21 shows a CM candidate. In (a) of FIG. 21, the position indicated by CT shows the position where the cut change detection output C[n] is found to be equal to 1 (and hence where a cut change is detected). In (b) of FIG. 21, the part M indicates that it is in a broadcasting mode of some sort or another. In (c) of FIG. 21, S1, S2, S3 and S4 indicate that a spectrum component of some sort or another is there. In (d) of FIG. 21, AM indicates a change in the square-root amplitude and Q_1 through Q_{11} indicates the respective positions where the characteristic values Q_1 through Q_{11} are computationally determined by the additional requirement computing unit 20.

[208]

Now, each of the characteristic values Q_1 through Q_{11} that are computationally determined by the additional requirement computing unit 20 will be described below.

[209]

The characteristic value Q_1 is the front break length, or the length of the low sound level section (to be referred to as "front break section") located immediately before a CM candidate section, where A[n] is successively less than a predetermined threshold value A_{thsd}. In FIG. 21, the section between the corresponding dotted broken lines represents the front break length Q_1.

[210]

The characteristic value Q_2 is the rear break length, or the length of the low sound level section (to be referred to as "rear break section") located immediately after a CM candidate section, where A[n] is successively less than a predetermined threshold value A_{thsd}. In FIG. 21, the section between the corresponding dotted broken lines represents the rear break length Q_2.

[211]

The characteristic value Q_3 is the front break minimal amplitude. The front break minimal amplitude Q_3 is the smallest value of A[n] in the front break section.

[212]

The characteristic values Q_4 is the rear break minimal amplitude. The rear break minimal amplitude Q_4 is the smallest value of A[n] in the rear break section.

[213]

The characteristic value Q_5 is the left/right correlation value. The left/right correlation value Q_5 is that of the 2-channel audio signals $S_L[m]$ and $S_R[m]$ for left and right. They can be computationally determined by using formula (25) below and $A_{LR}[n]$, $A_{LL}[n]$ and $A_{RR}[n]$ obtained by formulas (16) through (18).

[214]

[Equation 15]

$$Q_5 = \frac{\sum_{n=n_s}^{n_e-1} A_{LR}[n]}{\sum_{n=n_s}^{n_e-1} A_{LL}[n] \sum_{n=n_s}^{n_e-1} A_{RR}[n]} \quad (25)$$

[215]

In the computation of formula (25), the original waveform is partly added for a plurality of times as frames are made to overlap but this problem does not significantly affect the system. If the memory capacity and the processing speed are large enough for maintaining the original waveform, the operation of formula (25) can be replaced by the mutual correlation of the waveform.

[216]

The characteristic value Q_6 is the average amplitude. The average amplitude Q_6 is the RMS of the amplitudes of the audio signals (root-mean-square amplitude) of the CM candidate section. This can be obtained by using formula (26) below.

[217]

[Equation 16]

$$Q_6 = \sqrt{\frac{1}{n_e - n_s} \sum_{n=n_s}^{n_e-1} A[n]} \quad (26)$$

[218]

In the computation of formula (26), as in the case of the computation of the left/right correlation value, the original waveform is partly added for a plurality of

times as frames are made to overlap but this problem does not significantly affect the system. If the memory capacity and the processing speed are large enough for maintaining the original waveform, the operation of formula (25) can be replaced by that of RMS of the original waveform.

[219]

The characteristic value Q_7 is the number of cuts. The number of cuts Q_7 is obtained by counting the number of cut changes (the number of CTs) in the CM candidate section. In other words, this is obtained by an operation of counting the number of times when C[n] = 1 occurs in section $[n_s, n_e)$.

[220]

The characteristic value Q_8 is the broadcasting mode. The broadcasting mode as used herein refers to the prevailing broadcasting mode in the CM candidate section. This is obtained by an operation of selecting the broadcasting mode Q_8 that appears most frequently in B[n] in $[n_s, n_e)$.

[221]

The characteristic value Q_9 is the number of adjacent candidates. The number of adjacent candidates Q_9 indicates that if the sounded sections found before and after the CM candidate are also CM candidates or not. The characteristic value Q_9 is equal to [2] when a CM candidate is found before and after the CM candidate and [1] when a CM candidate is found only before or after

the CM candidate. It is equal to [0] when no other CM candidate is found before and after the CM candidate. The operation of determining the number of adjacent candidates is realized by checking the CM candidate table. If there is a CM candidate that is immediately succeeding the CM candidate in question or not is determined by seeing if the sum of the starting time T_s, the length T_w and the rear break length Q_2 or $(T_s + T_w + Q_2)$ agrees with the starting time (T'_s) of some other CM candidate or not. Similarly, if there is a CM candidate that is immediately preceding the CM candidate in question or not is determined by seeing if the difference of the starting time T_s, and the front break length Q_1 or $(T_s - Q_1)$ agrees with the sum of the starting time T'_s and the length T'_w or $(T'_s + T'_w)$ of some other CM candidate or not.

[222]

The characteristic values Q_{10} and Q_{11} are the front spectrum difference energy and the rear spectrum difference energy. The front spectrum difference energy and the rear spectrum difference energy Q_{10} and Q_{11} are used to quantize the change in the sound quality at the boundary of a CM and the program containing the CM or at the boundary of a CM and another CM. These are defined as the square sum of the difference between the average spectrum values of the opposite sides of the boundary and obtained by using formulas (27) through (32) below;

[223]

[Equation 17]

$$S_1[k] = \frac{1}{N}\sum_{n=0}^{N-1} F\left[k; n_e' - n\right] \quad (27),$$

$$S_2[k] = \frac{1}{N}\sum_{n=0}^{N-1} F\left[k; n_s + n\right] \quad (28),$$

$$S_3[k] = \frac{1}{N}\sum_{n=0}^{N-1} F\left[k; n_e - n\right] \quad (29),$$

$$S_4[k] = \frac{1}{N}\sum_{n=0}^{N-1} F\left[k; n_s' + n\right] \quad (30),$$

$$Q_{10} = \frac{1}{S_{norm}^2}\sum_k \left(S_2[k] - S_1[k]\right)^2 \quad (31) \text{ and}$$

$$Q_{10} = \frac{1}{S_{norm}^2}\sum_k \left(S_4[k] - S_3[k]\right)^2 \quad (32)$$

[224]

where N is the number of frames used for determining the average of spectrum values, n'_e is the number of the ending frame of the sounded section found immediately before the CM candidate section (see FIG. 21), n'_s is the number of the starting frame of the sounded section found immediately after the CM candidate section, $S_1[k]$ is the average spectrum immediately before the end of the sounded section that is found immediately before the CM candidate section, $S_2[k]$ is the average spectrum immediately after the start of the CM candidate section, $S_3[k]$ is

the average spectrum immediately before the end of the CM candidate section, $S_4[k]$ is the average spectrum immediately after the start of the sounded section that is found immediately after the CM candidate section and S_{norm} is an appropriate normalization constant.

[225]

The above described additional requirement computing unit 20 additionally describes the characteristic values Q_1 through Q_{11} that are determined in a manner as described above on the CM table 19a to produce the CM candidate table 20a as output. The CM candidate table 20a is sent output the additional requirement judging unit 21.

[226]

The additional requirement judging unit 21 receives the CM candidate table 20a as input and calculates the score R for the CM candidate by performing a parameter transform on the characteristic values of the CM candidate typically, using a threshold function, and subsequently weighting the obtained values so that the CM candidate is judged to be a strong candidate when R exceeds a predetermined threshold value. The additional requirement judging unit 21 additionally describes the score R and the result of score judgment Z to the CM candidate table 20a to produce the CM candidate table 21a as output.

[227]

FIG. 22 schematically illustrates the configuration of the additional requirement judging unit 21.

[228]

Referring to FIG. 22, the characteristic values Q_1 through Q_L of the CM candidate table 21a are sent to respective function computing units 50_1 through 50_L, which perform transform operations by using respective parameter transform functions $H_1()$ through $H_L()$ and then obtain the products of the outcomes of the respective computations and respective weights W_1 through W_L by means of respective weighting units 51_1 through 51_L. The characteristic values obtained as a result of the weighting operations, using the respective weighting units 51_1 through 51_L, are added by summation adder 52 to obtain the score R. The score R output from the summation adder 52 is compared with a predetermined threshold value by score judging unit 53 and, if the score R exceeds a predetermined threshold value, an output telling that the CM candidate is judged to be a strong CM candidate is produced. The CM candidate that is determined by the score judging unit 53 so as to be not exceeding the threshold value is erased from the table.

[229]

More specifically, the additional requirement judging unit 21 computes the score, using formula (33) below;

[230]

[Equation 18]

$$R = \sum_{l=1}^{L} W_l H_l(Q_l) \qquad (33)$$

[231]

where $H_l()$ is the parameter transform function predetermined for each of the characteristic values, W_l is the predetermined weight and L is the number of characteristic values (= 11). Note that l represents a number between 1 and 11.

[232]

The parameter transform function $H_l()$ that is used by the function computing units 50_1 through 50_L may be a rectangular function, which is the most simple function. For example, rectangular function Rect(x; t_1, t_2) as shown in (b) of FIG. 23 may be used and t_{11} and t_{21} may be selected for the lower and upper limits of the reference value that is predetermined for each of the characteristic values. Then, if formula (34) is used, 1 is given when Q_1 is found within the scope of the reference value, whereas 0 is given when Q_1 if found out of the scope of the reference value.

[233]

$$H_1(Q_1) = \text{Rect}(Q_1; t_1, t_2) \qquad (34)$$

If a smooth transition from 0 to 1 or vice versa is to be realized near each of

the boundaries, a sigmoid function Sigm(x; t_1, t_2) as expressed by formula (35) below may be used.

[234]

[Equation 19]

$$H_l(Q_l) = Sigm(Q_l; t_{1l}, t_{2l}) = \frac{1}{1+\exp\left(-(x-t_{1l})/\sigma_{1l}\right)} \cdot \frac{1}{1+\exp\left((x-t_{2l})/\sigma_{2l}\right)}$$

(35)

[235]

In FIG. 23, (c) schematically shows such smooth transitions. In FIG. 23, σ_{11} and σ_{21} are constants defining the profile of transition that are to be selected in advance typically by referring to the distribution of characteristic value.

[236]

While the weight W_l applied by the weighting units 51_1 through 51_L may be artificially selected in advance on the basis of the statistic properties of the characteristic values, it is also possible to select the weight by making the device learn known learning samples typically by means of a neural network (see, inter alia, Nakagawa, "Pattern Information Processing", Maruzen (1999). In formula (35), l represents any number between 1 and 11.

[237]

The operation of score judgment of said judging unit 53 is performed by processing the threshold value for score R, using formula (36) below;

[238]

$$Z = \text{Unit}\ (R - t_r) \qquad (36)$$

where Unit (x) is a unit step function whose value is 1 when $x > 0$ and 0 when $x < 0$ as shown in (a) of FIG. 23 and t is a judgment threshold value that is predetermined or automatically selected as a result of a learning process.

[239]

Then, the rule judging unit 22 receives the CM candidate table 21a obtained as a result of the score judgment of the additional requirement judging unit 21 as input and produces the CM starting time and the CM length as final CM detection output 4a that is obtained as a result of a predetermined rule judging operation as will be described hereinafter. That is, the rule judging unit 22 effects rule processing, thus selecting the most prominent CM candidate if there are two or more CM candidates at the same time. (The event that two or more CM candidates coexist shall be referred to as "competing relationship".)

[240]

Now, the operation of the rule judging unit 22 will be described by referring to the flow chart of FIG. 24.

[241]

Firstly, in Step S70, the rule judging unit 22 selects a CM candidate for judgment from the CM candidate table. The selected CM candidate is the oldest candidate in the CM candidate table that has survived for a predetermined time period T_4, which is long enough for containing several CMs and may typically be 150 seconds.

[242]

Subsequently, in Step S71, the rule judging unit 22 checks the CM candidate table to see if any other CM candidate is found in the selected CM candidate section (which is the period from T_s to $T_s + T_w$). If it is determined in Step S71 that there is not any other CM candidate in the selected CM candidate section (No), the CM candidate is output as CM detection output and erased from the CM candidate table.

[243]

If, on the other hand, it is determined in Step S71 that there is another CM candidate in the selected CM candidate section (Yes), it is so judged that they are competing and the minimum length prioritizing rule is firstly applied to them in Step S72. With the minimum length prioritizing rule, the time section comprising a shorter CM candidate is prioritized among a number of time sections having a uniform length and comprising one or more than one CM candidates with different time lengths. More specifically, if there are a time section having a length of 30

seconds and comprising a single 30 seconds long CM candidate and a time section having a length of 30 seconds and comprising two 15 seconds long CM candidates, the 15 seconds long CM candidates are selected and the 30 seconds long CM candidate is discarded.

[244]

The minimum length prioritizing rule will be described further by referring to FIG. 25 that illustrates an example.

[245]

In FIG. 25, (a) shows a section where four CMs including CM1 through CM4 are successively broadcast, whereas (b) shows that eight CM candidates A through H are found in the CM candidate table.

[246]

Firstly, as the CM candidate of A is subjected to judgment as shown in (c) of FIG. 25, E and H compete with A. However, since section E can be described by A and B and section H can be described by A, B, C and D, they are discarded and hence A is selected. Subsequently, as the CM candidate of B is subjected to judgment as shown in (d) of FIG. 25, F appears as competing section (note that E and H have already been discarded because A is adopted). However, since section F can be described by B and C, it is discarded and hence B is adopted. Similarly, as the CM candidate of C is subjected to judgment as shown in (e) of FIG. 25, G

appears as competing section. However, since section G can be described by C and D, it is discarded and hence C is adopted. Finally, as the CM candidate of D is subjected to judgment as shown in (f) of FIG. 25, there is no longer any competitor and it is no longer necessary to apply the rule. Therefore, D is adopted.

[247]

As a result of the above operation, A, B, C and D are selected from the time section as CM candidates. If there arises a competing situation to which this rule cannot be applied, all the CM candidates are left in the table and the processing operation will simply be terminated.

[248]

Returning to FIG. 24, after the judgment in Step S72, the operation of the rule judging unit 22 proceeds to Step S73, where the rule judging unit 22 determines if the CM candidate being subjected to judgment is discarded or not as a result of the application of the minimum length prioritizing rule. If it is determined in Step S73 that the CM candidate being subjected to judgment is discarded (Yes), the rule judging unit 22 erases the candidate from the CM candidate table and returns to Step S70. If, on the other hand, it is determined in Step S73 that the CM candidate being subjected to judgment is not discarded (No), the rule judging unit 22 checks the CM candidate table in Step S74 to see if there is

any other CM candidate found in the time section of the CM candidate that is being subjected to judgment.

[249]

If it is determined in Step S74 that there is not any other CM candidate (No), the rule judging unit 22 outputs the CM candidate being subjected to judgment as detection output and erase it from the CM candidate table in Step S80. If, on the other hand, it is determined in Step S74 that there is at least another CM candidate (Yes), the rule judging unit 22 proceeds to Step S75.

[250]

In Step S75, the rule judging unit 22 applies the adjacency prioritizing rule to the CM candidate. With the adjacency prioritizing rule, if there are a plurality of CM candidates that are competing with each other, priority is given to the CM candidate having adjacent CM candidates that immediately precedes and succeeds it.

[251]

The adjacency prioritizing rule will be described further by referring to FIG. 26, illustrating an example.

[252]

In FIG. 26, (a) shows that four CMs, or CM 11 through CM 14, are broadcast successively in a time section and (b) shows that there exist a total of six

candidates, or candidates I through N, for the time section. The candidates M and N are selected as candidates simply because they incidently contains cut changes and low sound levels. It will be appreciated that, while such candidates are falsely selected for the time section, they survived the score judgment process for the additional requirements that is conducted to judge if the candidates are probably CMs or not because they contain CMs.

[253]

In the above example, the oldest CM candidate I is firstly subjected to judgment as shown in (c) of FIG. 26. While M competes with I, I has an adjacent candidate J but M does not have any adjacent candidate so that I is adopted and M is discarded. Then, the CM candidate J is subjected to judgment as shown in (d) of FIG. 26. While N completes with J, J has an adjacent candidate I and K but N does not have any adjacent candidate so that J is adopted and N is discarded. Subsequently, since the remaining CM candidates K, L do not have any competitor as shown in (e) and (f) of FIG. 26, both K and L are adopted without problem.

[254]

As a result of the above processing operation, I, J, K and L are selected as CM candidates from the time section of FIG. 26.

[255]

When none of the competing candidates have any adjacent candidate and

when a plurality of candidates have respective adjacent candidates, none of them are discarded and left in the CM candidate table.

[256]

Returning to FIG. 24, after the operation of Step S75, the rule judging unit 22 proceeds to Step S76, where the rule judging unit 22 determines if the CM candidate being subjected to judgement is discarded or not as a result of the application of the adjacency prioritizing rule. If it is determined in Step S76 that the CM candidate being subjected to judgment is discarded (Yes), the rule judging unit 22 erases the candidate from the CM candidate table and returns to Step S70. If, on the other hand, it is determined in Step S76 that the CM candidate being subjected to judgment is not discarded (No), the rule judging unit 22 checks the CM candidate table in the next Step S77 to see if there is any other CM candidate found in the time section of the CM candidate that is being subjected to judgment.

[257]

If it is determined in Step S77 that there is not any other CM candidate (No), the rule judging unit 22 outputs the CM candidate being subjected to judgment as detection output and erase it from the CM candidate table in Step S80. If, on the other hand, it is determined in Step S77 that there is at least another CM candidate (Yes), the rule judging unit 22 proceeds to Step S78. Where the rule judging unit 22 applies the score prioritizing rule to the CM candidate. With the score prioritizing

rule, if the competing situation is not dissolved as a result of the application of the above rules, the candidate having a higher score R given as a result of the score judgment of the additional requirement judging unit 21 has priority. This score prioritizing rule is repeatedly applied until the competing situation is dissolved.

[258]

The score prioritizing rule will be described by referring to FIG. 27, illustrating an example.

[259]

In FIG. 27, (a) shows that four CMs, or CM 21 through CM 24, are broadcast successively in a time section and (b) shows that there exist a total of seven candidates, or candidates P through W, for the time section.

[260]

In the above example, the oldest CM candidate P is firstly subjected to judgment as shown in (c) of FIG. 27 and competing with U. The competing situation is not dissolved by applying the minimum length prioritizing rule and the adjacency prioritizing rule.

[261]

Therefore, all the competing situations related to the competing candidates are retrieved from the CM candidate table. Hence there are six competing situations (P-U), (U-Q), (Q-V), (V-R), (R-W) and (W-S), involving seven

candidates, and the candidate having the highest score is selected by applying the score prioritizing rule. In the above example, R has the highest judgment score of (2.0) and therefore R having this score is adopted and the candidates V, W that are competing with R are discarded as shown in (d) of FIG. 27.

[262]

However, as shown in (e) of FIG. 27, the completing relationship of (P-U) is not dissolved by the above described adoption of R. Therefore, again, all the competing situations related to the competing candidates are retrieved from the CM candidate table. Since V is discarded, there are only two competing situations (P-U) and (U-Q), involving three candidates.

[263]

Of the above candidates, the candidate Q having the highest judgment score of (1.9) is adopted and the candidate U that is competing with Q is discarded as shown in (f) of FIG. 27.

[264]

With the above processing operation, there does not remain any competing situation, involving P, so that P is adopted. Additionally, U, V and W are discarded, while Q, R and S are adopted.

[265]

It will be appreciated that, if all the related competing situations are not

retrieved and the score prioritizing rule is applied only to the competing situations of the candidates being judged, firstly U is adopted and P is discarded. Subsequently, because of the competing situation of U and Q, U that is once adopted is also discarded. Therefore, the rule judging unit 22 retrieves all the related competing situations in order to eliminate the risk of erroneously and incidentally discarding proper candidates because of the processing sequence that is determined only by chance.

[266]

Thus, all the competing situations of the selected candidates can be eliminated by the application of the score prioritizing rule.

[267]

Returning to FIG. 24, after the processing operation of Step S78, the rule judging unit 22 proceeds to Step S79, where the rule judging unit 22 determines if the candidates being subjected to judgement is discarded or not as a result of the application of the score prioritizing rule. If it is determined in Step S79 that the CM candidate being subjected to judgment is discarded (Yes), the rule judging unit 22 erases the candidate from the CM candidate table and returns to Step S70. If, on the other hand, it is determined in Step S79 that the CM candidate being subjected to judgment is not discarded (No), the rule judging unit 22 outputs the starting time and the length of the CM as CM detection output in Step S80 and

erases the CM candidate from the CM candidate table before it returns to Step S70.

[268]

As described above, the above described first example of CM detecting section 202 of this embodiment firstly deterministically extracts CM candidates from the program on the basis of the indispensable requirements that almost all CMs satisfy, selects CM candidates by statistically evaluating the characteristic values of each CM candidate on the basis of the additional requirements that are used to indicate probable CMs and then dissolves any overlapping relationship of candidates on the basis of the logical requirement in order to accurately detect CMs. While this embodiment is adapted to a video/audio recording apparatus adapted to currently prevalent analog TV broadcasting, it will be appreciated that the CM detecting section 202 is applicable to digital TV broadcasting. It will be appreciated that, when the embodiment is applied to radio broadcasting, the part of the CM detecting section 202 for processing video signals can be omitted.

[269]

Now, a second example of CM detecting section 202 of the embodiment of the present invention will be described below.

[270]

FIG. 28 illustrates in detail the configuration of the second example of CM detecting section 202 of the embodiment of the invention.

[271]

This example of CM detecting section 202 is adapted to handle only the basic ones of the above described additional requirements. More specifically, of the additional requirements 1) through 14), 11) through 14) are not used for the CM detecting section 202 to simplify the configuration thereof. (preventing the intricacy)

[272]

Like the first example of CM detecting section 202 shown in FIG. 15, this second example of CM detecting section 202 comprises a front end section and a rear end section. In FIG. 28, the components that are same as their counterparts of FIG. 15 are denoted respectively by the same reference symbols and will not be described any further.

[273]

Referring to FIG. 28, therefore, only the additional components (101, 102, 103) and the extended function of the additional requirement computing unit 20 will be described below.

[274]

The sound source identifying unit 101 of the front end section receives a digitized and framed audio signal 2b as input and outputs the sound source name of the frame of the audio signal 2b. The sound source may be voice, music, voice

and music and others. Any of the technologies illustrated in Kohchi et al., "Automatic Classification of Broadcast Sounds on the Basis of VQ distortions", Journal of the Society of Telecommunication Technology, DSP97-95/SP97-50, 43/48 (1998), Minami et al., "Video Indexing and Applications thereof Using Sound Information", Paper of the Society of Telecommunication Technology, Vol. J81-D-II, No. 3, 529/537 (1998) and the specification and the drawing of Abe's Japanese Patent Application No.11-190693 may be utilized for the purpose of the identifying the sound source of the input audio signal.

[275]

A numerical value is assigned to each of the sound source names identified by the sound source identifying unit 101. The numerical values that can be used for the purpose of the invention may include voice = 1 and music =2. The numerical value of each sound source is then input to the characteristic value buffer 18 as characteristic value U[n].

[276]

The program category data or the program category identifying unit 102 arranged at the front end section is used to output the category name of the program being processed. The program category names that can be used for the purpose of the invention include news, drama, baseball and soccer. Program category data may be obtained from a TV program guide or a TV program table. Nowadays,

program category data can be obtained automatically by way of Internet. Alternatively, it is also possible to use a device adapted to automatically identify the category of the program being broadcast on the basis of the audio and video signals of the program without resorting to external information. The technology illustrated in the specification and the drawing of Abe's Japanese Patent Application No. 11-190693 may be utilized for the purpose of the identifying the program category form the audio and video signals of the program being broadcast.

[277]

A numerical value is assigned to each of the program category names identified by the program category data or the program category identifying unit 102 on a frame by frame basis. The numerical values that can be used for the purpose of the invention may include news=1 and drama=2. The numerical value of each program category is then input to the characteristic value buffer 18 as characteristic value W[n].

[278]

Otherwise, the front end section has a configuration same as that of FIG. 15.

[279]

In the case of the above described second example, the front end section is made to comprise the sound source identifying unit 101 and the program category

data or the program category identifying unit 102 so that the characteristic values U[n] and W[n] obtained by them are stored in the characteristic value buffer 18. Thus, the characteristic value G[n] of formula (21) stored in the characteristic value buffer 18 is expanded to formula (37) below.

[280]

$$G[n] \equiv \{C[n], A[n], A_{LR}[n], A_{LL}[n], A_{RR}[n], F[k;n], B[n], T[n], U[n], W[n]\} \quad (37)$$

While the rear end section of the CM detector 19 of this example is exactly same as that of FIG. 15, the CM candidate tables 19a through 21a of this second example are extended in a manner as described below. In the case of this second example, the CM candidate tables 19a through 21a are extended in such a way that the characteristic values Q_{12} through Q_{15} to the above described characteristic values Q_1 through Q_{11} as shown in FIG. 29. Note that, in FIG. 29, the characteristic values Q_1 through Q_{11} are omitted and not shown.

[281]

The CM probability data base 103 of the rear end section stores in advance the probability of transmission of each CM obtained as a function of time slot and the probability of transmission of each CM obtained as a function of program category and the elapsed time of program. The probabilities are read out from the CM probability data base 103 by referring to the current time and input to the

additional requirement computing unit 20. The probability data stored in the CM probability data base 103 can be obtained by statistically processing the actually broadcast programs.

[282]

Thus, the additional requirement computing unit 20 of the second example is extended to carry out the operations of computing the characteristic values Q_{12} through Q_{15} to the characteristic values Q_1 through Q_{11}.

[283]

The characteristic value Q_{12} is obtained by checking if the CM candidate being examined contains one or more than one voice sections or not. The characteristic value Q_{12} that shows if the CM candidate contains one ore more than one voice sections or not is determined by using formula (38) below.

[284]

[Equation 20]

$$Q_{12} = \begin{cases} 1(if\ ^{\exists}U[n] = (\ )or\ ^{\exists}U[n] = (\ )for\ n_s \le n < n_e) \\ 0(otherwise) \end{cases} \quad (38)$$

[285]

Like the presence or absence of voice, the characteristic value Q_{13} is obtained by checking if the CM candidate being examined contains one or more than one music sections or not. The characteristic value Q_{13} that shows if the CM

candidate contains one ore more than one music sections or not is determined by using formula (39) below.

[286]

[Equation 21]

$$Q_{13} = \begin{cases} 1\left(if\ {}^{\exists}U[n] = (\ )or\ {}^{\exists}U[n] = (\ )for\ n_s \le n < n_e\right) \\ 0(otherwise) \end{cases} \quad (39)$$

[287]

The characteristic value Q_{14} is the probability of occurrence of the CM in question as determined on the basis of the current time (time slot probability). The additional requirement computing unit 20 uses the probability of broadcasting the CM obtained from the CM probability data base 103 directly as the characteristic value Q_{14}.

[288]

The characteristic value Q_{15} is the probability of occurrence of the CM in question as determined on the basis of program category of the current program and the elapsed time from the start of the program (program category probability). The additional requirement computing unit 20 uses the probability of broadcasting the CM obtained from the CM probability data base 103 directly as the characteristic value Q_{15}.

[289]

The arrangement of the CM detecting section 202 downstream to the additional requirement judging unit 21 is same as that the CM detecting section 202 of FIG. 15 except that the variables are extended to include the characteristic values Q_{12} through Q_{15} and therefore will not be described here any further.

[290]

As a result of the above described extension, the CM detecting section 202 of this example can detect CMs on the basis of the sound sources of the broadcast signal, taking the current time and the program category into consideration.

[291]

FIG. 30 is a schematic block diagram of the hardware components of the CM detecting section 202 of the embodiment that can be used for the purpose of the invention and illustrated in FIGS. 15 and 28.

[292]

Referring to FIG. 30, the A/D converter 40 has the function of the A/D converters 10 and 13 of FIGS. 15 and 28 and the memory 41 has the function of the frame memory 11 and that of audio signal buffer 14.

[293]

The A/V processor, or DSP (digital signal processor) 42 has the functions of the cut change detector 112, the amplitude detector 15, the correlation detector 16, the spectrum detector 17, the sound source identifier 101 and so on and the

memory 43 has the function of the characteristic value buffer 18.

[294]

The processor 44 has functions of the CM candidate detector 19, the additional requirement computing unit 20, the additional requirement judging unit 21, the rule judging unit 22, the CM probability data base 103 and so on.

[295]

Either the A/V processor, or the DSP (digital signal processor) 42 or the processor 44 may be made to have the function of the operation control section 23.

[296]

[Effect of the Invention]

In short, according to the invention, since the first signal section is detected out of an input signal and then extracted and recorded according to the result of the detection of the first signal section, it is now possible to detect a CM as the first signal out of a broadcast signal, or the input signal, so that the CM can be stored, viewed/listened to and/or retrieved without problem.

[Brief Description of the Drawings]

FIG. 1 is a schematic block diagram of a preferred embodiment of broadcast signal processing device according to the invention;

FIG. 2 is a schematic block diagram of a subset of the embodiment including the CM detecting section, the CM extracting section and the CM

recording section;

FIG. 3 is a flow chart of the operation of the subset of FIG. 2;

FIG. 4 is a schematic illustration of discretization of an input audio signal and an input video signal and processing frames to be used for the signals;

FIG. 5 is a schematic block diagram of a subset of the embodiment including the CM detecting section, the CM extracting section, the CM characteristics extracting section and the CM recording section;

FIG. 6 is a flow chart of the operation of the subset of FIG. 5;

FIG. 7 is a schematic illustration of an image that can be displayed on the display screen of the display section of the embodiment;

FIG. 8 is a schematic block diagram of a subset of the embodiment including the CM recording section, the CM index generating section, the CM viewing section and the CM selecting section;

FIG. 9 is a flow chart of the operation of the subset of FIG. 8;

FIG. 10 is a schematic block diagram of a subset of the embodiment including the CM recording section and the characteristics comparing section,

FIG. 11 is a flow chart of the operation of the subset of FIG. 10;

FIG. 12 is a schematic illustration of another image that can be displayed on the display screen of the display section of the embodiment (to show retrieval icons);

FIG. 13 is a schematic block diagram of a subset of the embodiment including the CM recording section, the characteristics comparing section, the CM index generating section, the CM viewing section and the CM selecting section;

FIG. 14 is a flow chart of the operation of the subset of FIG. 13;

FIG. 15 is a schematic block diagram of the CM detecting section, illustrating a possible first configuration thereof;

FIG. 16 is a flow chart of the operation of the video signal processing operation of the front end part of the CM detecting section of the embodiment;

FIG. 17 is a flow chart of the operation of the audio signal processing operation of the front end part of the CM detecting section of the embodiment;

FIG. 18 is a flow chart of the operation of the CM candidate detector of the CM detecting section of the embodiment;

FIG. 19 is a schematic illustration of the operation of computationally determining the requirements to be met for the embodiment;

FIG. 20 is a schematic illustration of a first possible CM candidate table that can be used in the CM detecting section of the embodiment;

FIG. 21 is a schematic illustration of the operation of computationally determining characteristic values of the additional requirement determining computer of the CM detecting section of the embodiment;

FIG. 22 is a schematic circuit diagram of the additional requirement

determining computer of the embodiment;

FIG. 23 is a schematic illustration of a unit step function, a rectangular function and a sigmoid type function that can be used for the operation of computationally determining scores in the embodiment;

FIG. 24 is flow chart of the operation of the rule determiner of the embodiment;

FIG. 25 is a schematic illustration of a minimum length prioritizing rule that can be used for the purpose of the invention;

FIG. 26 is a schematic illustration of an adjacency prioritizing rule that can be used for the purpose of the invention;

FIG. 27 is a schematic illustration of a score prioritizing rule that can be used for the purpose of the invention;

FIG. 28 is a schematic block diagram of the CM detecting section, illustrating a possible second configuration thereof;

FIG. 29 is a schematic illustration of a second possible CM candidate table (extended part only) that can be used in the CM detecting section of the embodiment; and

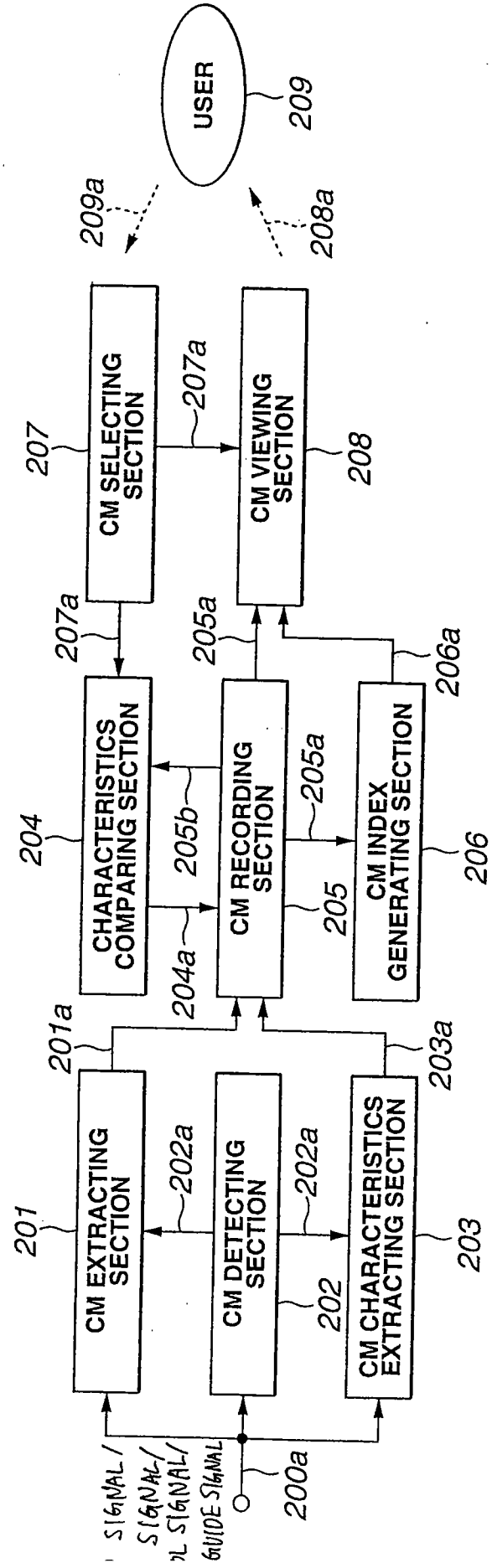
FIG. 30 is a schematic block diagram of the hardware components of the CM detection of the embodiment that can be used for the purpose of the invention.

[Explanation of Referenced Numerals]

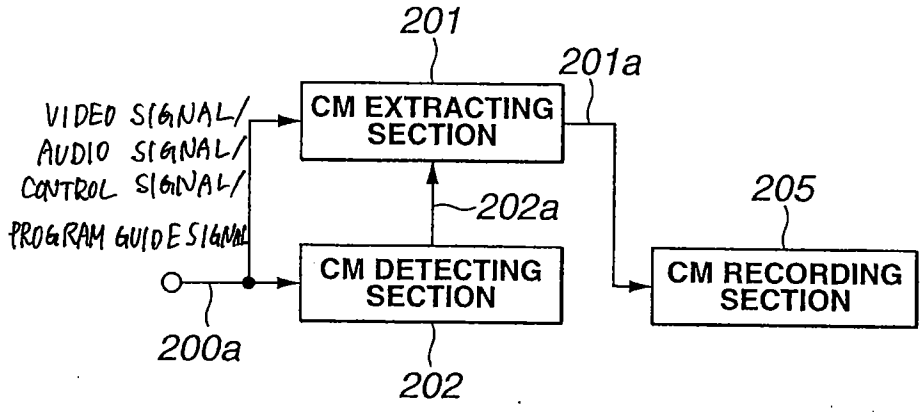
201 CM extracting section; 202 CM detecting section; 203 CM characteristics extracting section; 204 characteristics comparing section; 205 CM recording section; 206 CM index generating section; 207 CM selecting section; 208 CM viewing section; 801 display processor; 802 display section; 810 CM index images, or the video images; 811 CM reproduction icon; 812 sound reproduction icon; 813 preceding page icon; 814 succeeding page icon; 815 retrieval icon

[DOCUMENT NAME] DRAWING

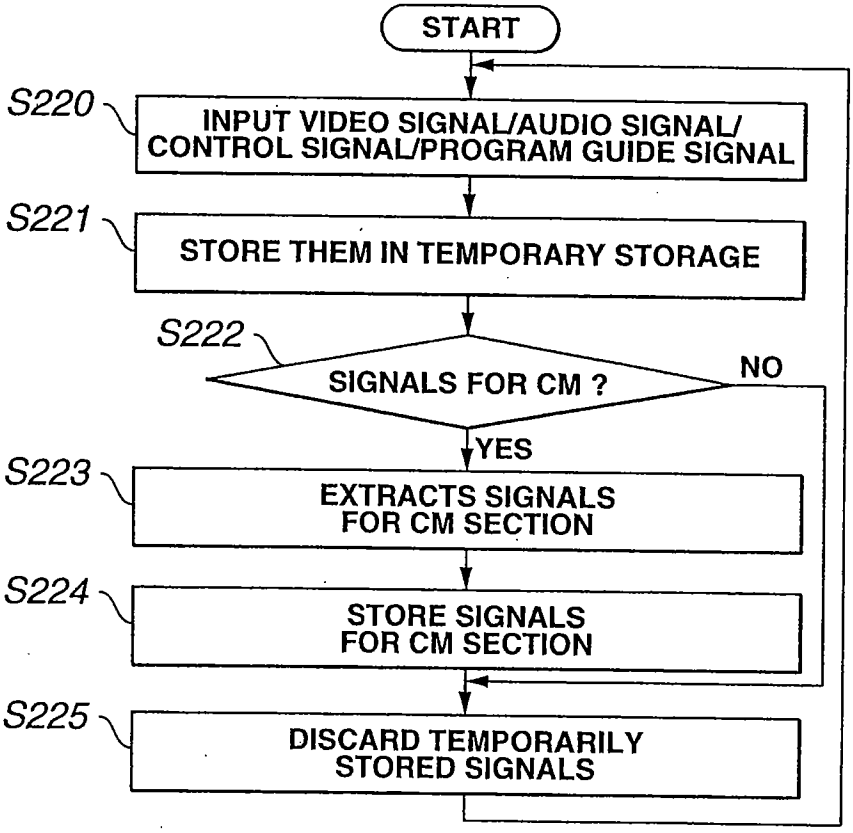
[FIG. 1]



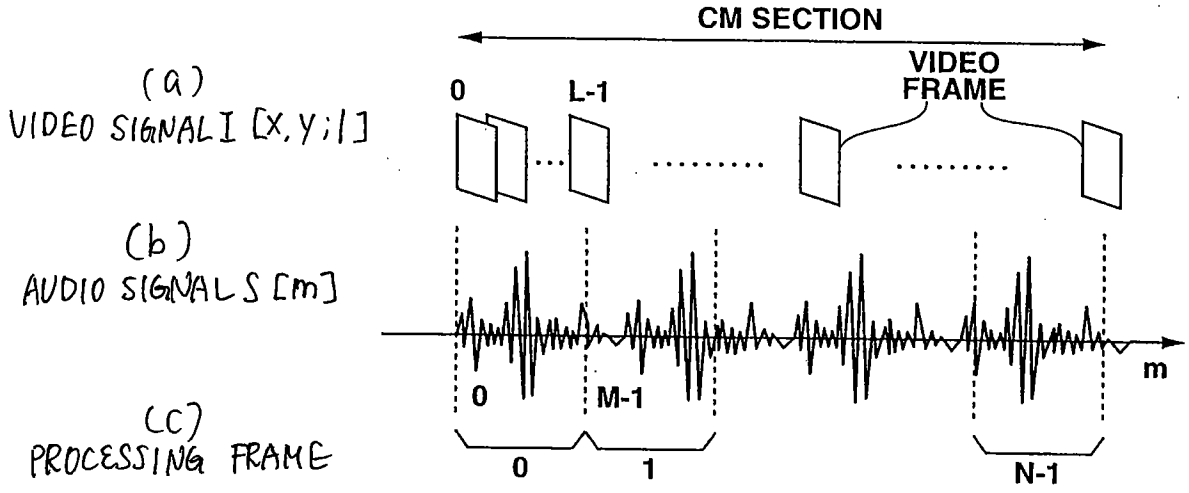
[FIG.2]


201
201a
VIDEO SIGNAL/
AUDIO SIGNAL/
CONTROL SIGNAL/
PROGRAM GUIDE SIGNAL
CM EXTRACTING SECTION
202a
205
CM DETECTING SECTION
CM RECORDING SECTION
200a
202

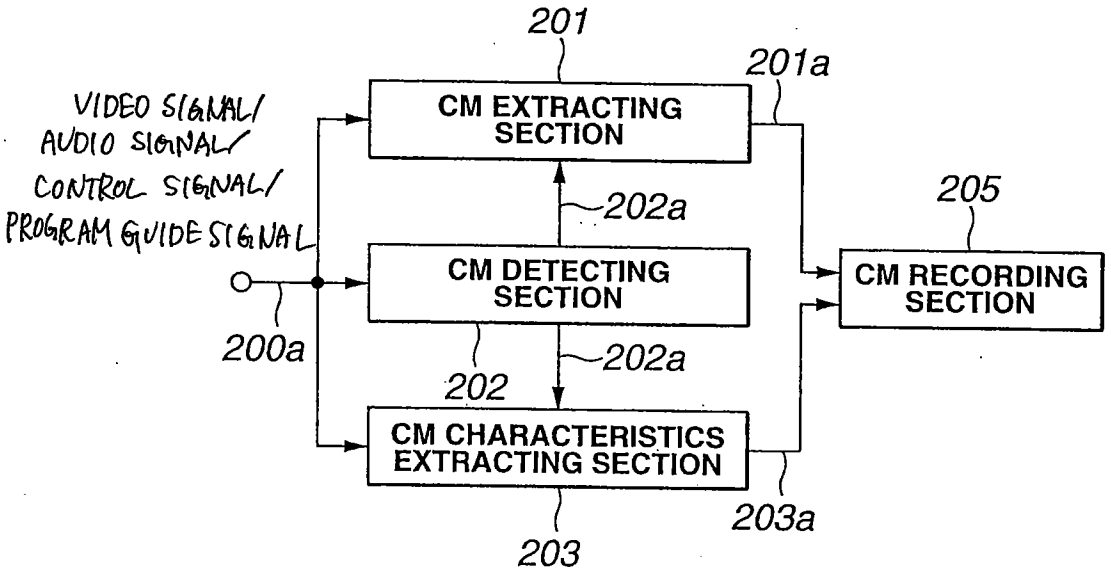
[FIG.3]


START
S220
INPUT VIDEO SIGNAL/AUDIO SIGNAL/ CONTROL SIGNAL/PROGRAM GUIDE SIGNAL
S221
STORE THEM IN TEMPORARY STORAGE
S222
SIGNALS FOR CM ?
NO
YES
S223
EXTRACTS SIGNALS FOR CM SECTION
S224
STORE SIGNALS FOR CM SECTION
S225
DISCARD TEMPORARILY STORED SIGNALS

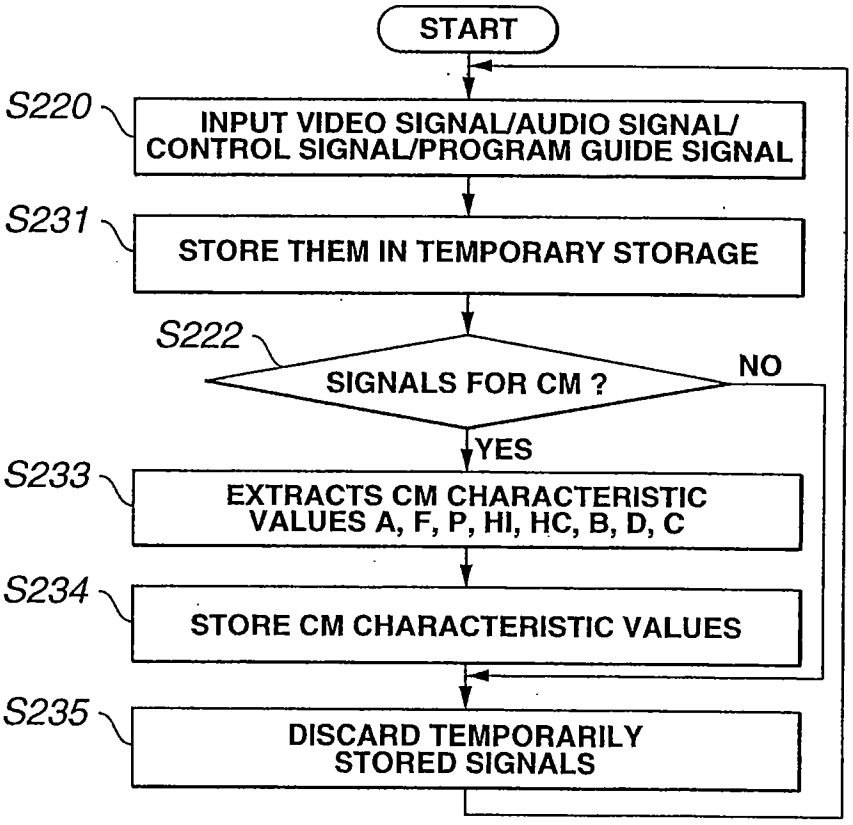
[FIG.4]


CM SECTION
(a)
VIDEO SIGNAL I [x, y; l]
0
L-1
VIDEO FRAME
(b)
AUDIO SIGNAL S [m]
0
M-1
m
(c)
PROCESSING FRAME
0
1
N-1

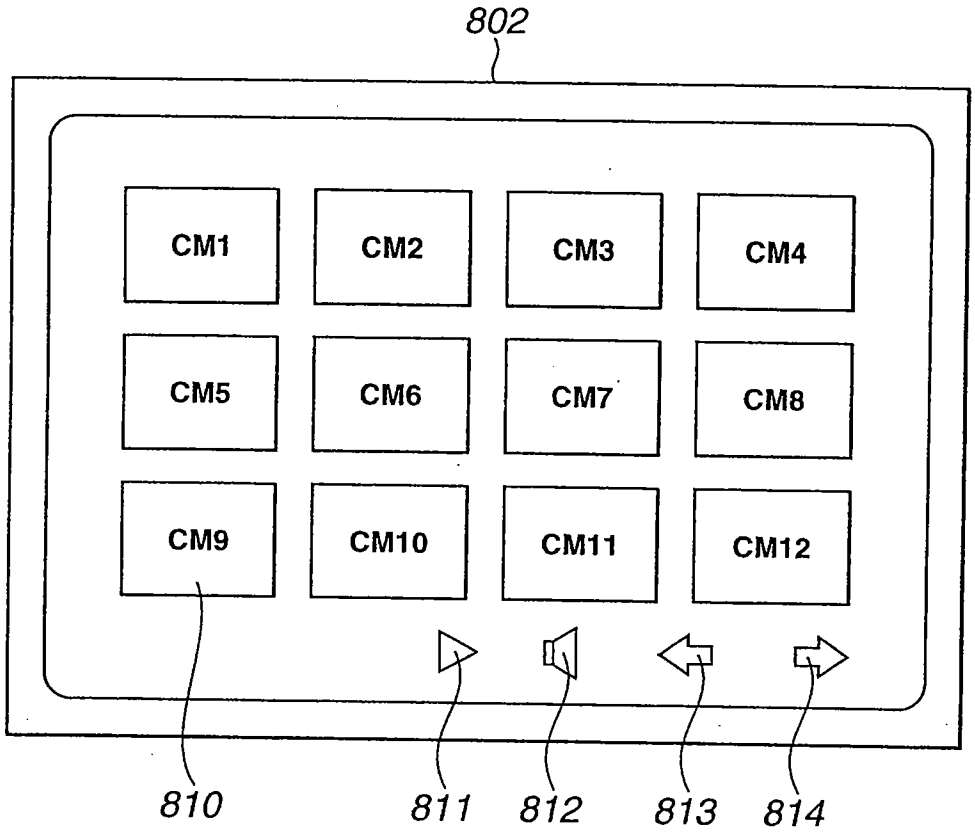
[FIG.5]


201
201a
VIDEO SIGNAL/
AUDIO SIGNAL/
CONTROL SIGNAL/
PROGRAM GUIDE SIGNAL
CM EXTRACTING SECTION
202a
205
CM DETECTING SECTION
CM RECORDING SECTION
200a
202a
202
CM CHARACTERISTICS EXTRACTING SECTION
203a
203

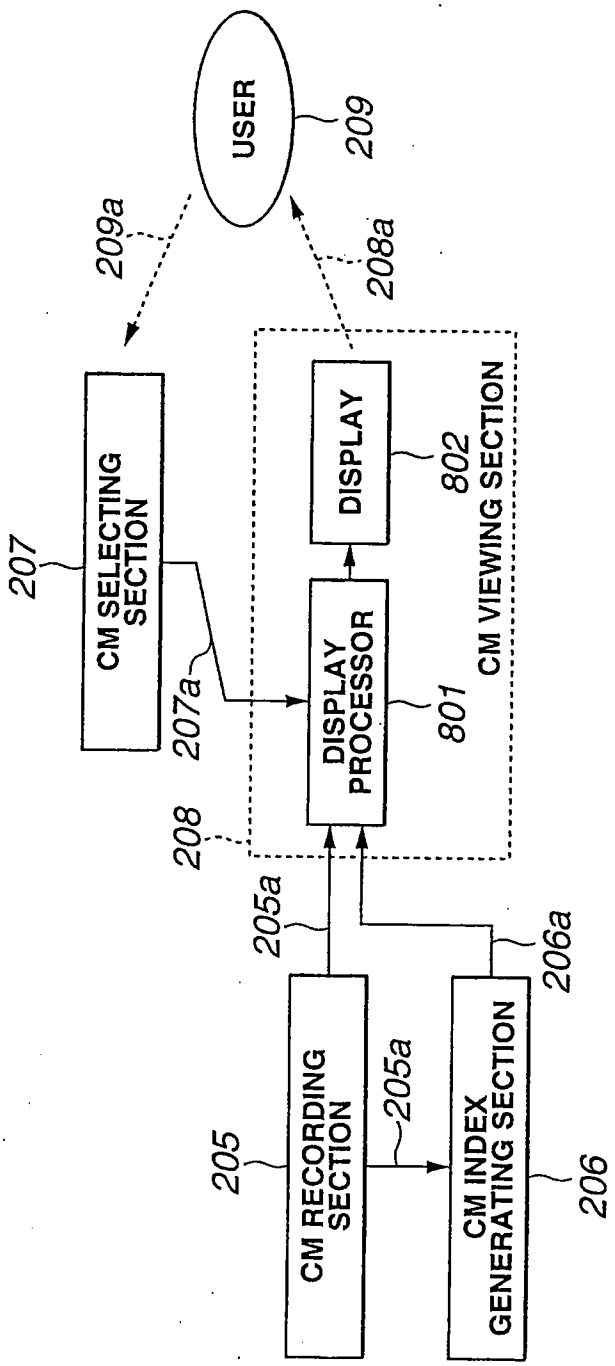
[FIG. 6]


START
S220
INPUT VIDEO SIGNAL/AUDIO SIGNAL/ CONTROL SIGNAL/PROGRAM GUIDE SIGNAL
S231
STORE THEM IN TEMPORARY STORAGE
S222
SIGNALS FOR CM ?
NO
YES
S233
EXTRACTS CM CHARACTERISTIC VALUES A, F, P, HI, HC, B, D, C
S234
STORE CM CHARACTERISTIC VALUES
S235
DISCARD TEMPORARILY STORED SIGNALS

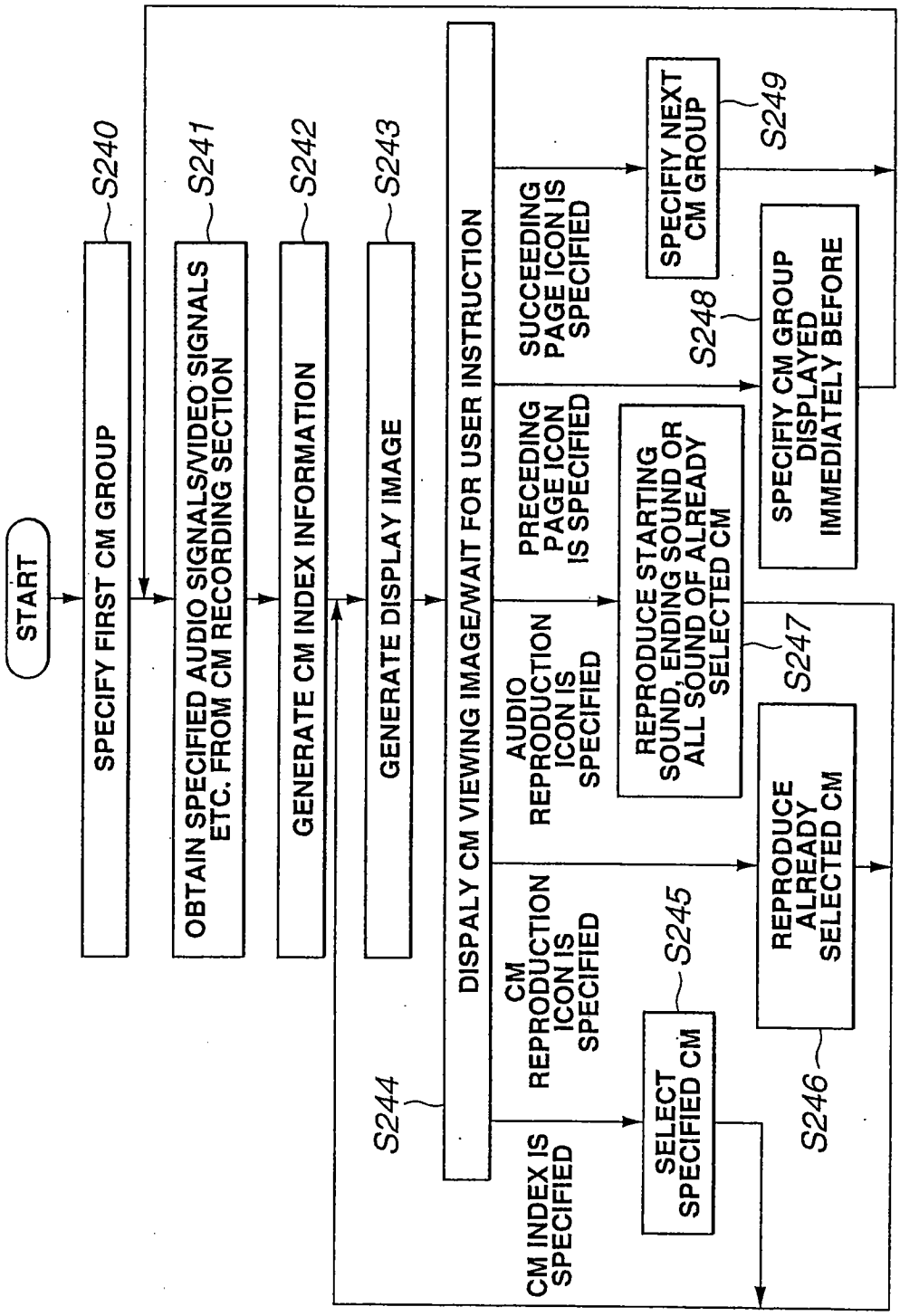
[FIG. 7]


802
CM1
CM2
CM3
CM4
CM5
CM6
CM7
CM8
CM9
CM10
CM11
CM12
810
811
812
813
814

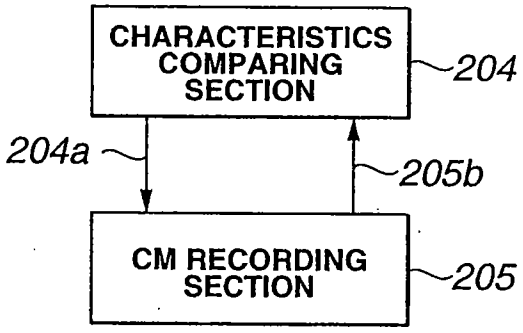
[FIG. 8]


USER
209
209a
208a
CM SELECTING SECTION
207
207a
DISPLAY
802
DISPLAY PROCESSOR
801
CM VIEWING SECTION
208
205a
206a
CM RECORDING SECTION
205
205a
CM INDEX GENERATING SECTION
206

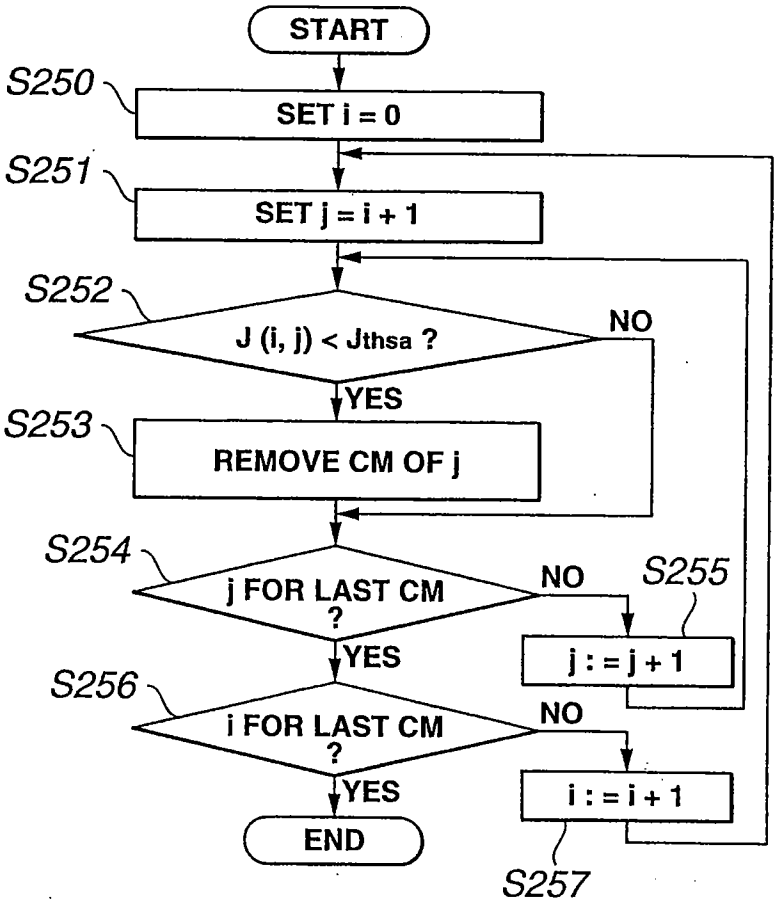
[FIG. 9]


START
SPECIFY FIRST CM GROUP
S240
OBTAIN SPECIFIED AUDIO SIGNALS/VIDEO SIGNALS ETC. FROM CM RECORDING SECTION
S241
GENERATE CM INDEX INFORMATION
S242
GENERATE DISPLAY IMAGE
S243
DISPALY CM VIEWING IMAGE/WAIT FOR USER INSTRUCTION
S244
CM INDEX IS SPECIFIED
SELECT SPECIFIED CM
S245
CM REPRODUCTION ICON IS SPECIFIED
REPRODUCE ALREADY SELECTED CM
S246
AUDIO REPRODUCTION ICON IS SPECIFIED
REPRODUCE STARTING SOUND, ENDING SOUND OR ALL SOUND OF ALREADY SELECTED CM
S247
PRECEDING PAGE ICON IS SPECIFIED
SPECIFIY CM GROUP DISPLAYED IMMEDIATELY BEFORE
S248
SUCCEEDING PAGE ICON IS SPECIFIED
SPECIFIY NEXT CM GROUP
S249

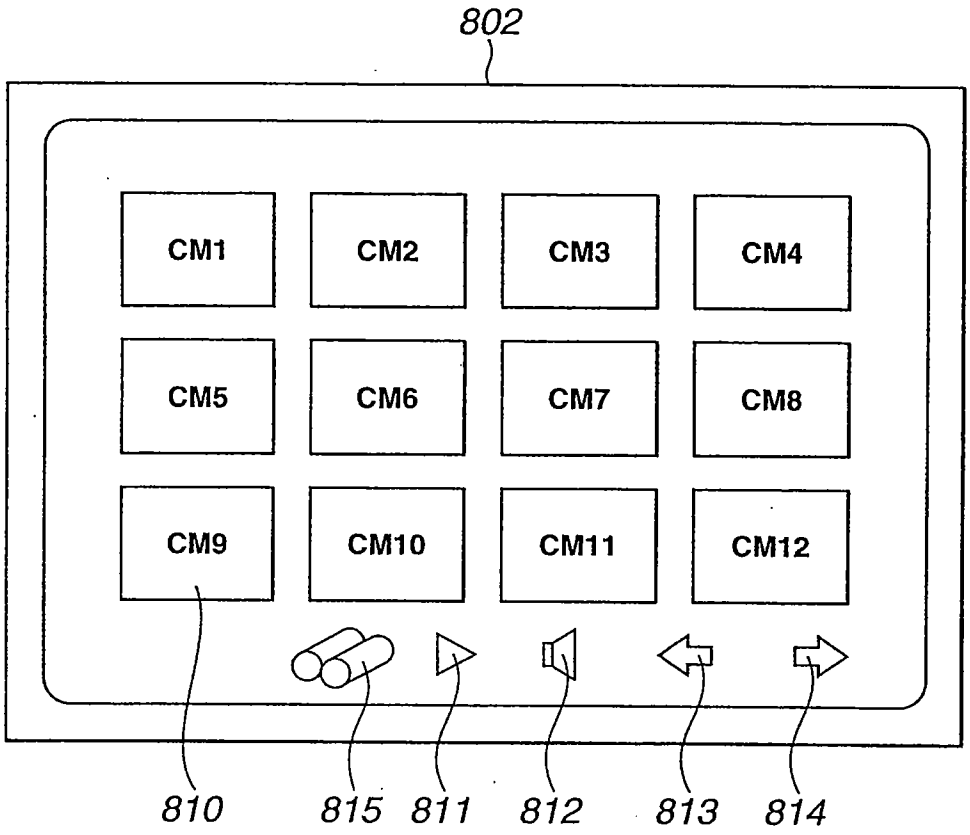
[FIG.10]


CHARACTERISTICS COMPARING SECTION
204
204a
205b
CM RECORDING SECTION
205

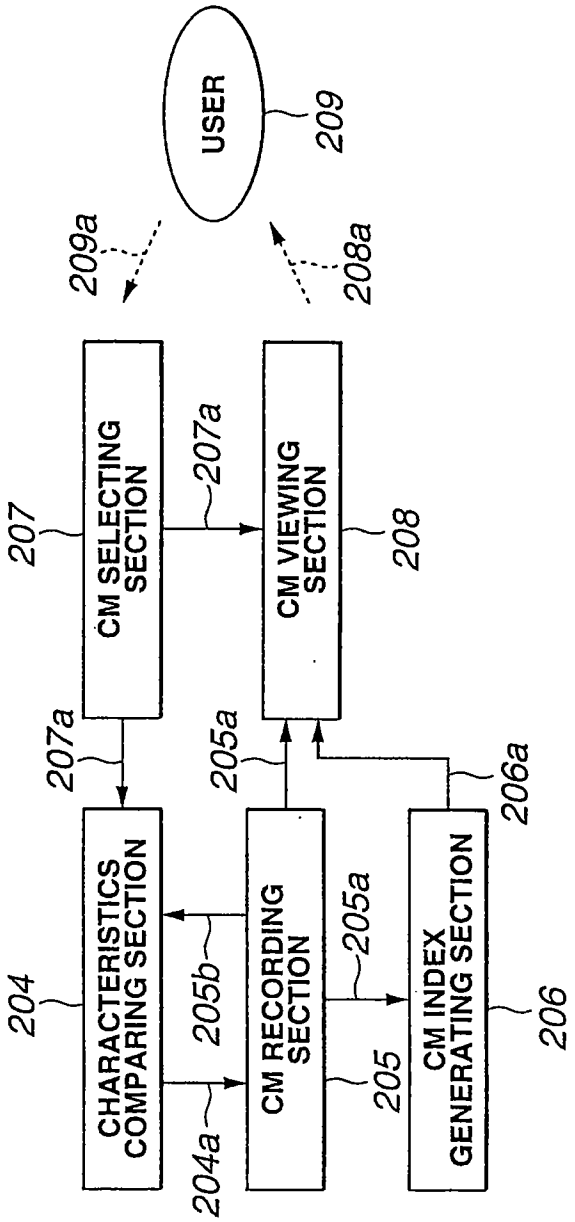
[FIG.11]


START
S250
SET i = 0
S251
SET j = i + 1
S252
J (i, j) < Jthsa ?
NO
YES
S253
REMOVE CM OF j
S254
j FOR LAST CM ?
NO
S255
YES
j : = j + 1
S256
i FOR LAST CM ?
NO
YES
i : = i + 1
END
S257

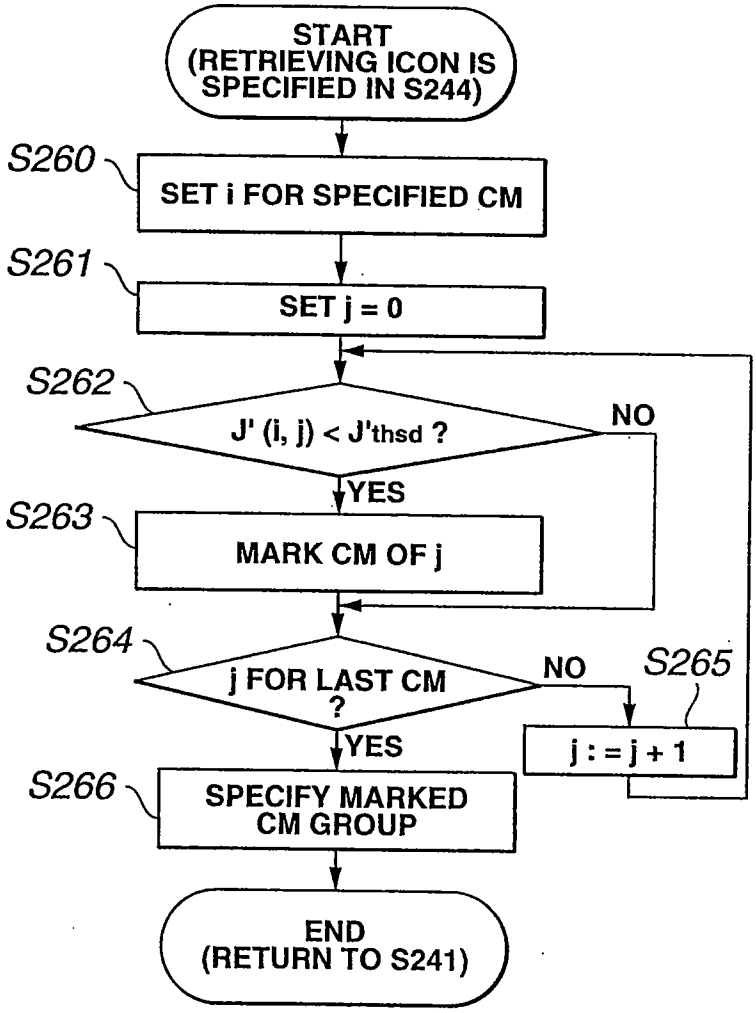
[FIG.12]


802
CM1
CM2
CM3
CM4
CM5
CM6
CM7
CM8
CM9
CM10
CM11
CM12
810
815
811
812
813
814

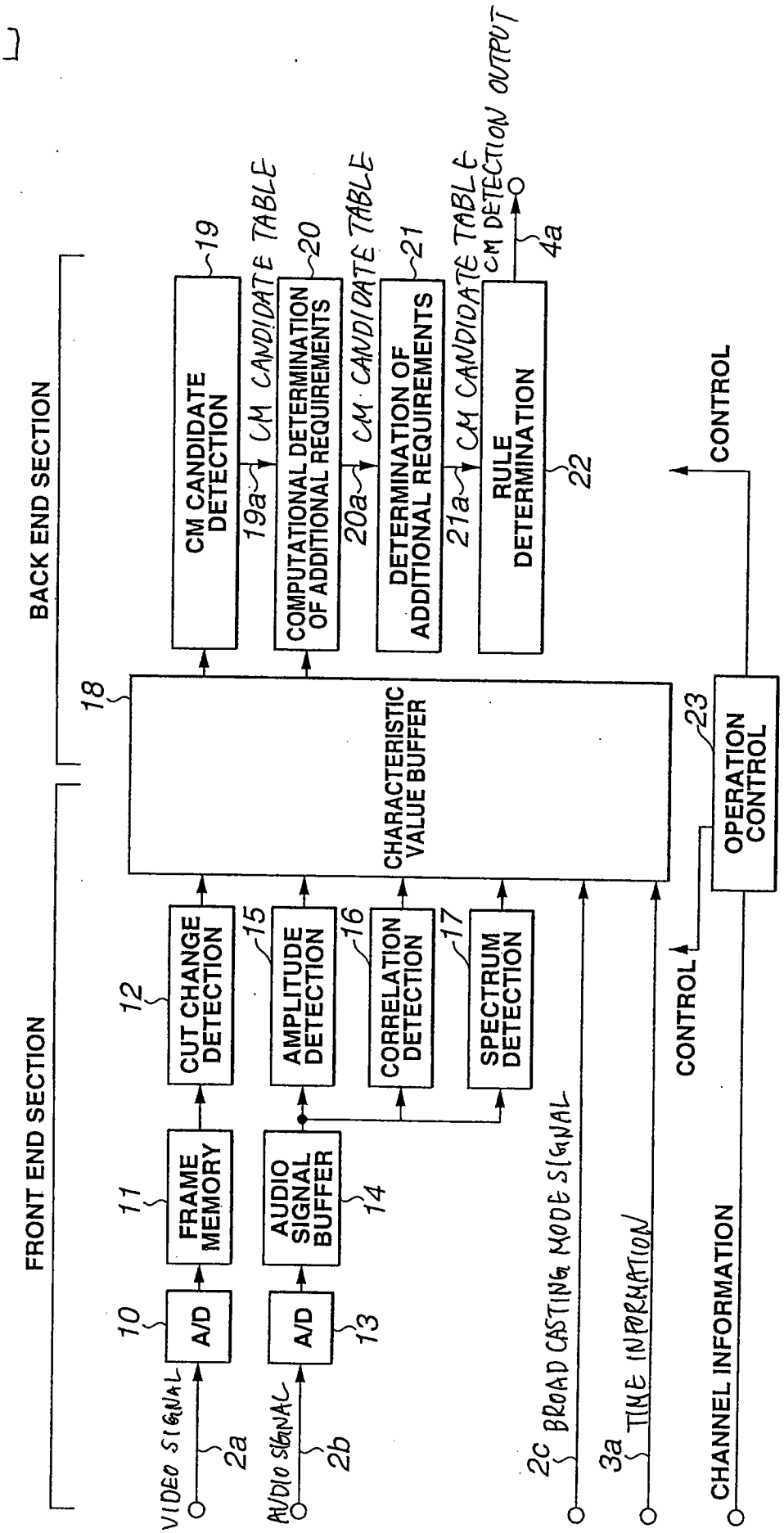
[FIG. 13]


USER
209
209a
208a
CM SELECTING SECTION
207
207a
CM VIEWING SECTION
208
207a
205a
206a
CHARACTERISTICS COMPARING SECTION
204
205b
CM RECORDING SECTION
205a
CM INDEX GENERATING SECTION
206
204a
205

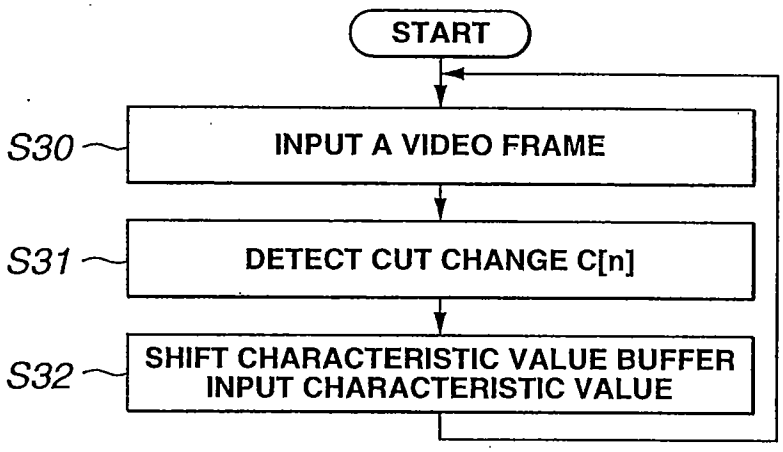
[FIG. 14]


START
(RETRIEVING ICON IS SPECIFIED IN S244)
S260
SET i FOR SPECIFIED CM
S261
SET j = 0
S262
J' (i, j) < J'thsd ?
NO
YES
S263
MARK CM OF j
S264
j FOR LAST CM ?
NO
S265
j : = j + 1
YES
S266
SPECIFY MARKED CM GROUP
END
(RETURN TO S241)

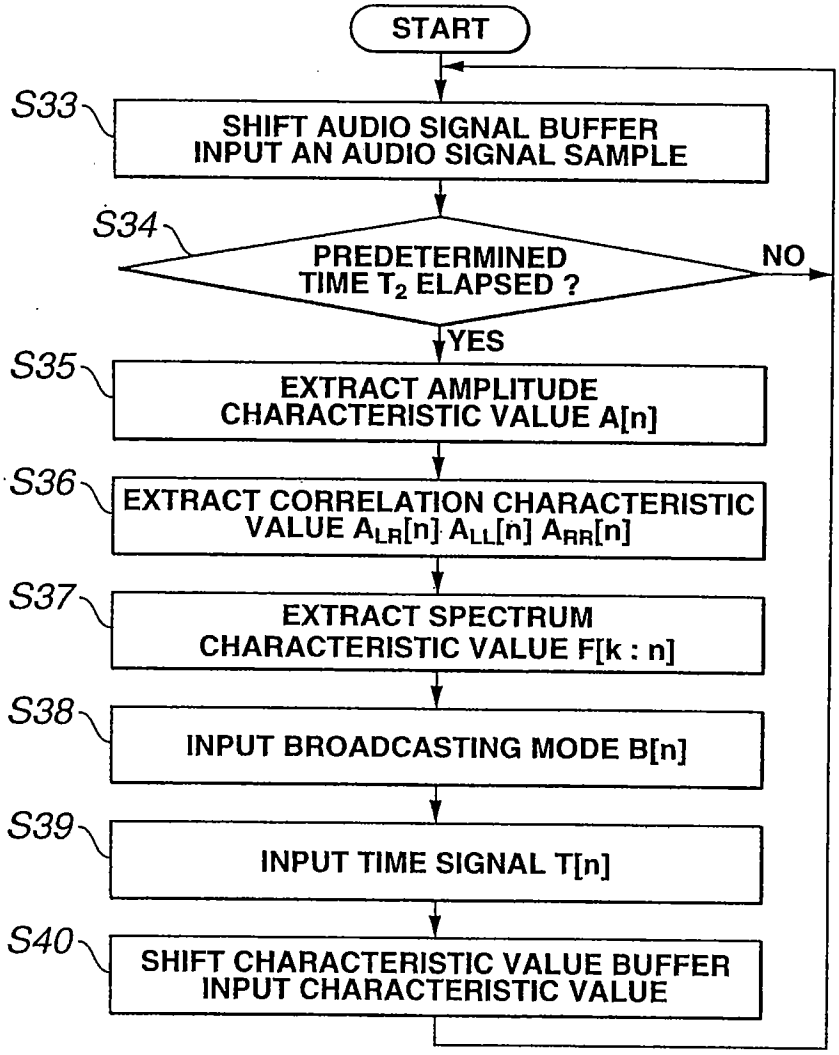
[FIG.15]


FRONT END SECTION
BACK END SECTION
VIDEO SIGNAL
2a
AUDIO SIGNAL
2b
2c BROAD CASTING MODE SIGNAL
3a TIME INFORMATION
CHANNEL INFORMATION
10
A/D
11
FRAME MEMORY
12
CUT CHANGE DETECTION
13
A/D
14
AUDIO SIGNAL BUFFER
15
AMPLITUDE DETECTION
16
CORRELATION DETECTION
17
SPECTRUM DETECTION
18
CHARACTERISTIC VALUE BUFFER
19
CM CANDIDATE DETECTION
19a CM CANDIDATE TABLE
20
COMPUTATIONAL DETERMINATION OF ADDITIONAL REQUIREMENTS
20a CM CANDIDATE TABLE
21
DETERMINATION OF ADDITIONAL REQUIREMENTS
21a CM CANDIDATE TABLE
22
RULE DETERMINATION
4a CM DETECTION OUTPUT
23
OPERATION CONTROL
CONTROL
CONTROL

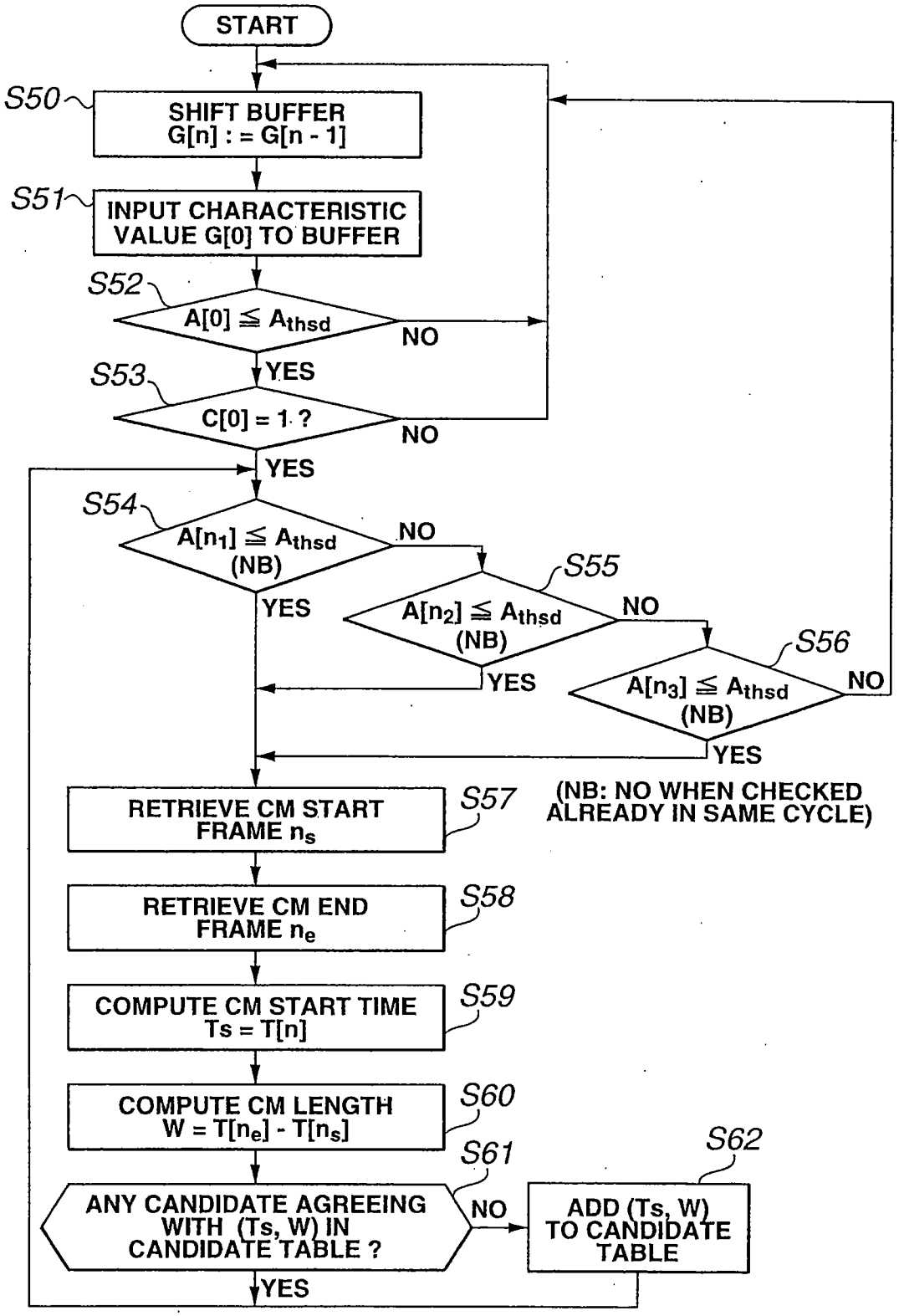
[FIG.16]


START
S30
INPUT A VIDEO FRAME
S31
DETECT CUT CHANGE C[n]
S32
SHIFT CHARACTERISTIC VALUE BUFFER
INPUT CHARACTERISTIC VALUE

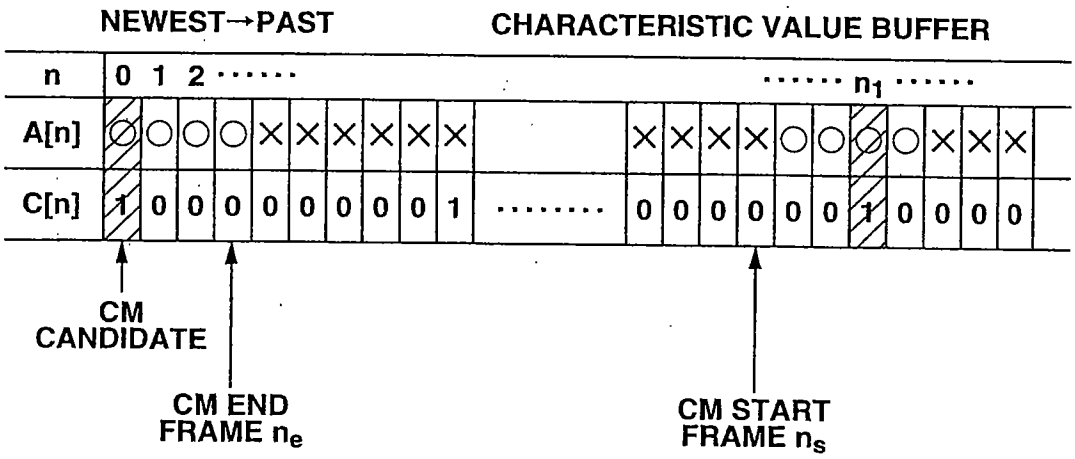
[FIG. 17]


START
S33
SHIFT AUDIO SIGNAL BUFFER
INPUT AN AUDIO SIGNAL SAMPLE
S34
PREDETERMINED
TIME T_2 ELAPSED ?
NO
YES
S35
EXTRACT AMPLITUDE
CHARACTERISTIC VALUE A[n]
S36
EXTRACT CORRELATION CHARACTERISTIC
VALUE $A_{LR}[n]$ $A_{LL}[n]$ $A_{RR}[n]$
S37
EXTRACT SPECTRUM
CHARACTERISTIC VALUE F[k : n]
S38
INPUT BROADCASTING MODE B[n]
S39
INPUT TIME SIGNAL T[n]
S40
SHIFT CHARACTERISTIC VALUE BUFFER
INPUT CHARACTERISTIC VALUE

[FIG. 18]


START
S50
SHIFT BUFFER
G[n] : = G[n - 1]
S51
INPUT CHARACTERISTIC VALUE G[0] TO BUFFER
S52
A[0] ≦ Athsd
NO
YES
S53
C[0] = 1 ?
NO
YES
S54
A[n1] ≦ Athsd (NB)
NO
YES
S55
A[n2] ≦ Athsd (NB)
NO
YES
S56
A[n3] ≦ Athsd (NB)
NO
YES
(NB: NO WHEN CHECKED ALREADY IN SAME CYCLE)
RETRIEVE CM START FRAME ns
S57
RETRIEVE CM END FRAME ne
S58
COMPUTE CM START TIME Ts = T[n]
S59
COMPUTE CM LENGTH W = T[ne] - T[ns]
S60
S61
ANY CANDIDATE AGREEING WITH (Ts, W) IN CANDIDATE TABLE ?
NO
YES
S62
ADD (Ts, W) TO CANDIDATE TABLE

[FIG. 19]

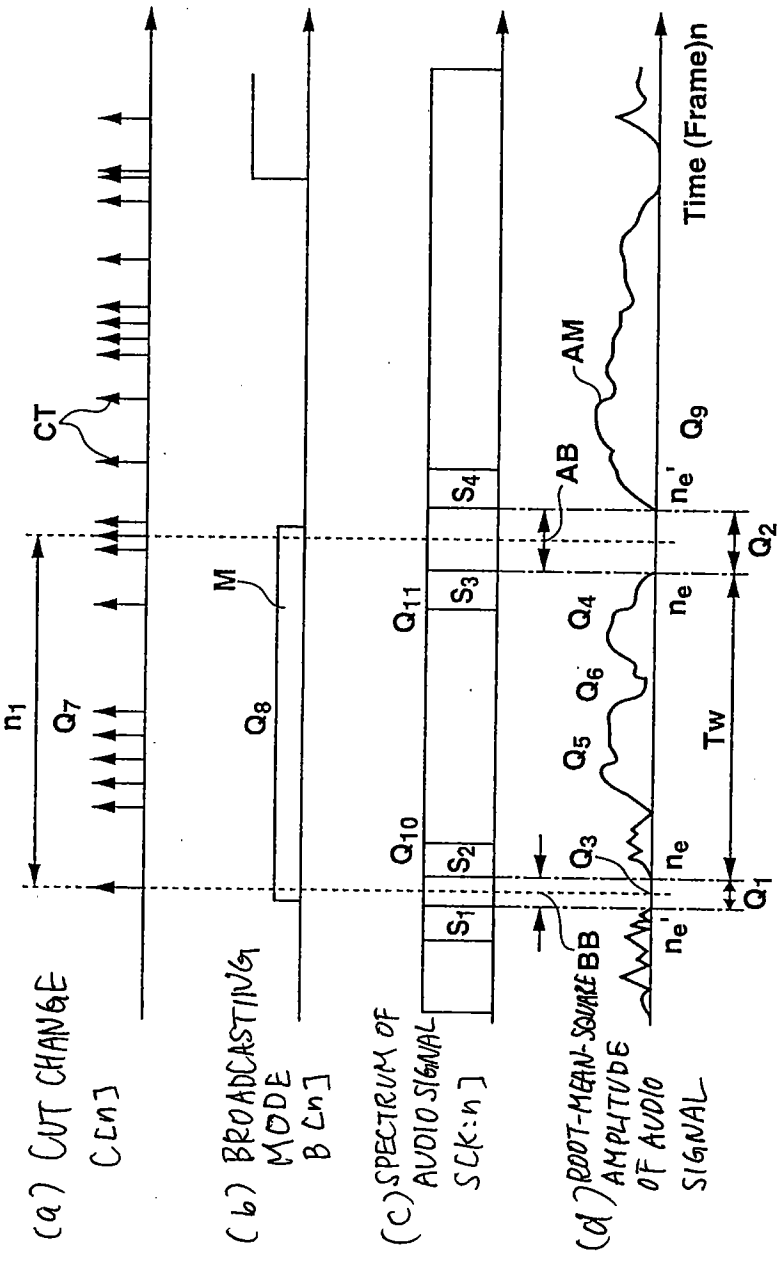

NEWEST→PAST
CHARACTERISTIC VALUE BUFFER
n
0 1 2 ·····
····· n1 ·····
A[n]
C[n]
1 0 0 0 0 0 0 0 0 1 ····· 0 0 0 0 0 0 1 0 0 0 0
CM CANDIDATE
CM END FRAME ne
CM START FRAME ns

[Fig. 20]

ITEM	SIGN	UNIT	REQUIREMENT EXAMPLE (19a)	ADDITIONAL REQUIREMENT EXAMPLE (20a)	JUDGEMENT EXAMPLE (21a)
START TIME	Ts	hour/minute/second	1:23'45	1:23'45	1:23'45
LENGTH (SOUNDED LENGTH)	Tw	second	14.63	14.63	14.63
FRONT BREAK LENGTH	Q_1	ms	-	300.0	300.0
REAR BREAK LENGTH	Q_2	ms	-	300.0	300.0
FRONT BREAK MINIMAL AMPLITUDE	Q_3	NB	-	0.00015	0.00015
REAR BREAK MINIMAL AMPLITUDE	Q_4	NB	-	0.00020	0.00020
LEFT-RIGHT CORRELATION VALUE	Q_5	-	-	0.934	0.934
AVERAGE AMPLITUDE	Q_6	NB	-	0.010	0.010
NUMBER OF CUTS	Q_7	number	-	9	9
BROADCASTING MODE	Q_8	-	-	1	1
NUMBER OF ADJACENT CANDIDATES	Q_9	number	-	2	2
FRONT SPECTRUM DIFFERENTIAL ENERGY	Q_{10}	-	-	0.41	0.41
REAR SPECTRUM DIFFERENTIAL ENERGY	Q_{11}	-	-	0.63	0.63
SCORE	R	-	-	-	1.80
RESULT OF SCORE JUDGEMENT	Z	-	-	-	1

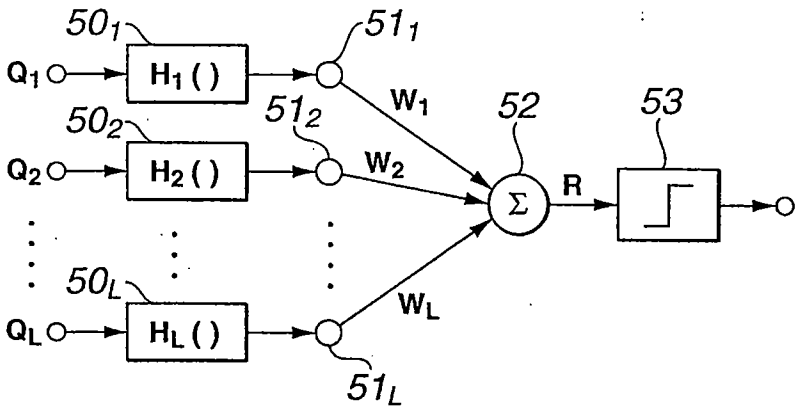
NB: THE VALUE RELATING TO THE AMPLITUDE OF THE AUDIO SIGNAL IS EXPRESSED IN TERMS OF RATIO RELATIVE TO THE MAXIMUM AMPLITUDE

[FIG. 21]

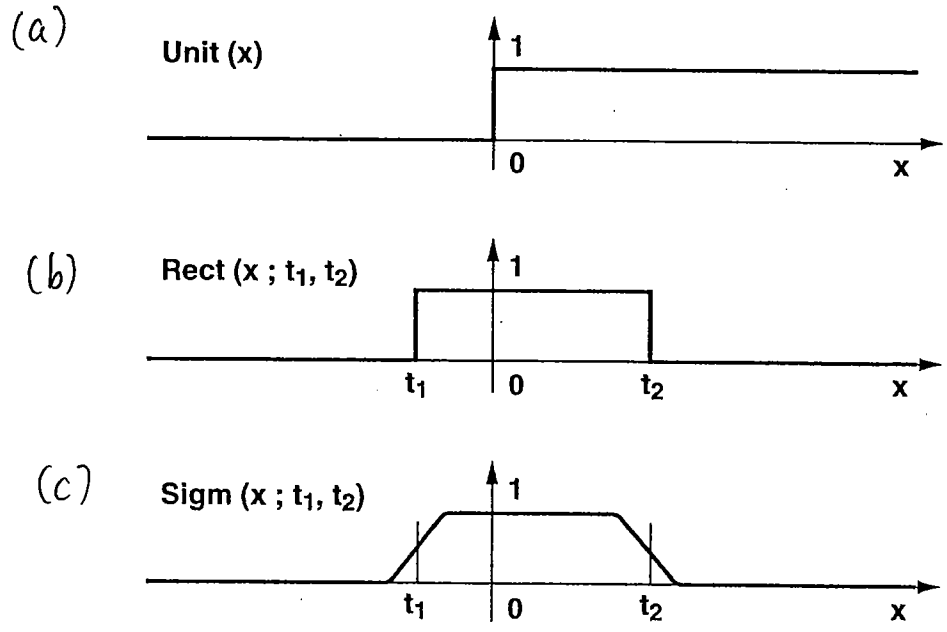


* $A_{LR}[n]$, $A_{LL}[n]$ AND $A_{RR}[n]$ ARE USED FOR THE COMPUTATION OF Q_5

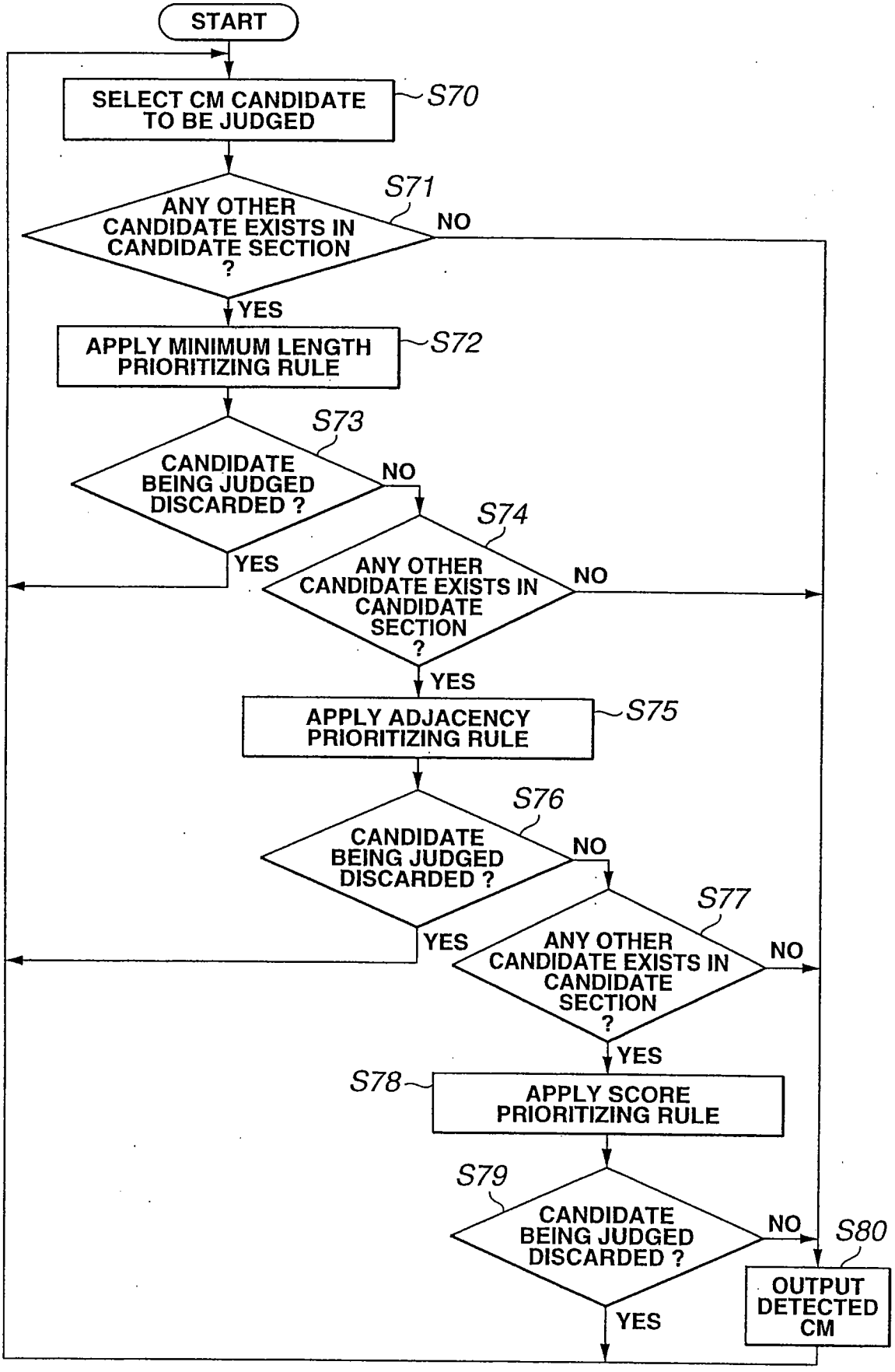
[FIG. 22]


50_1
51_1
Q_1
$H_1(\,)$
W_1
50_2
51_2
Q_2
$H_2(\,)$
W_2
52
53
R
Σ
50_L
Q_L
$H_L(\,)$
W_L
51_L

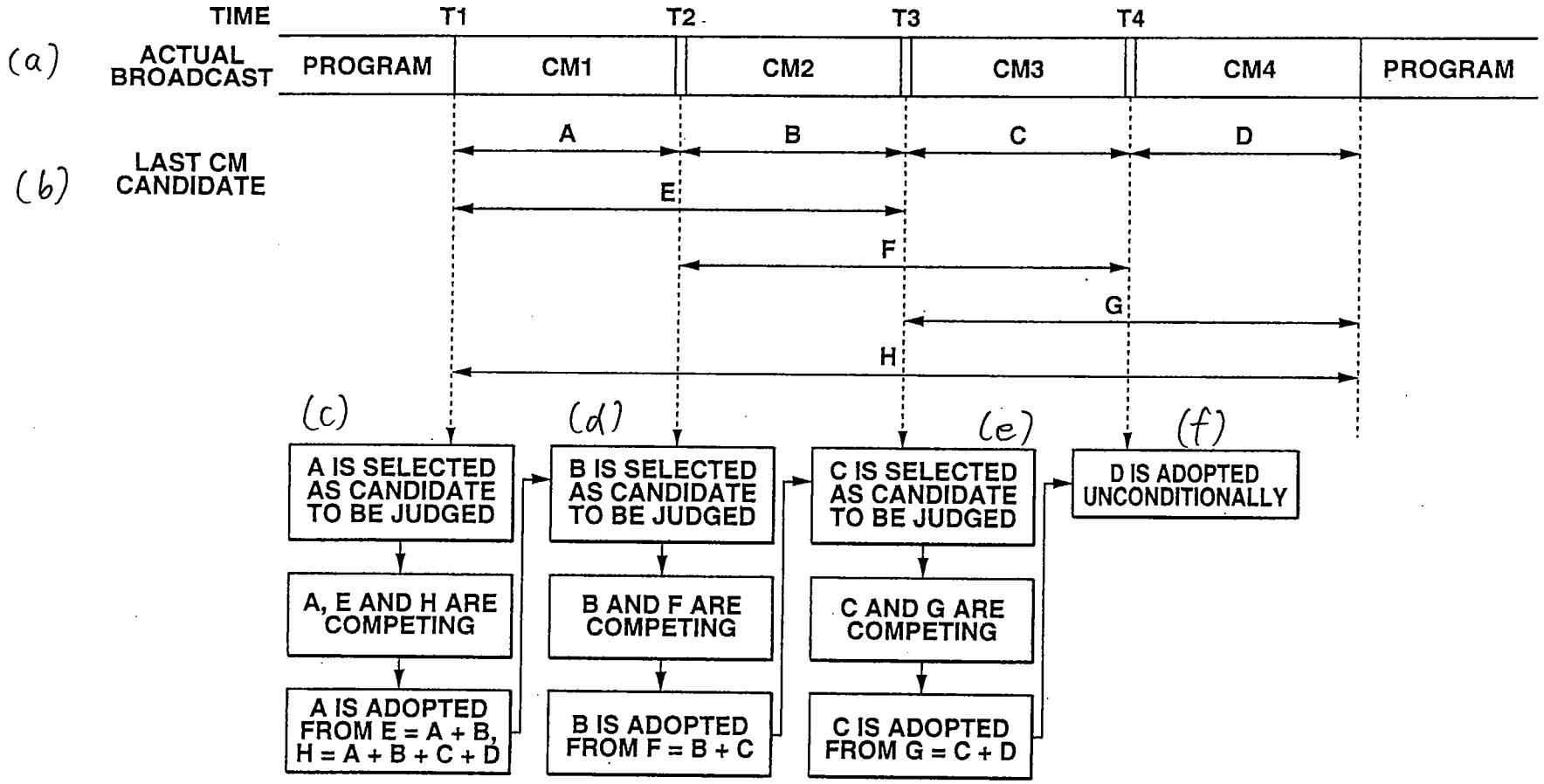
[FIG. 23]


(a)
Unit (x)
1
0
x
(b)
Rect (x ; t_1, t_2)
1
t_1
0
t_2
x
(c)
Sigm (x ; t_1, t_2)
1
t_1
0
t_2
x

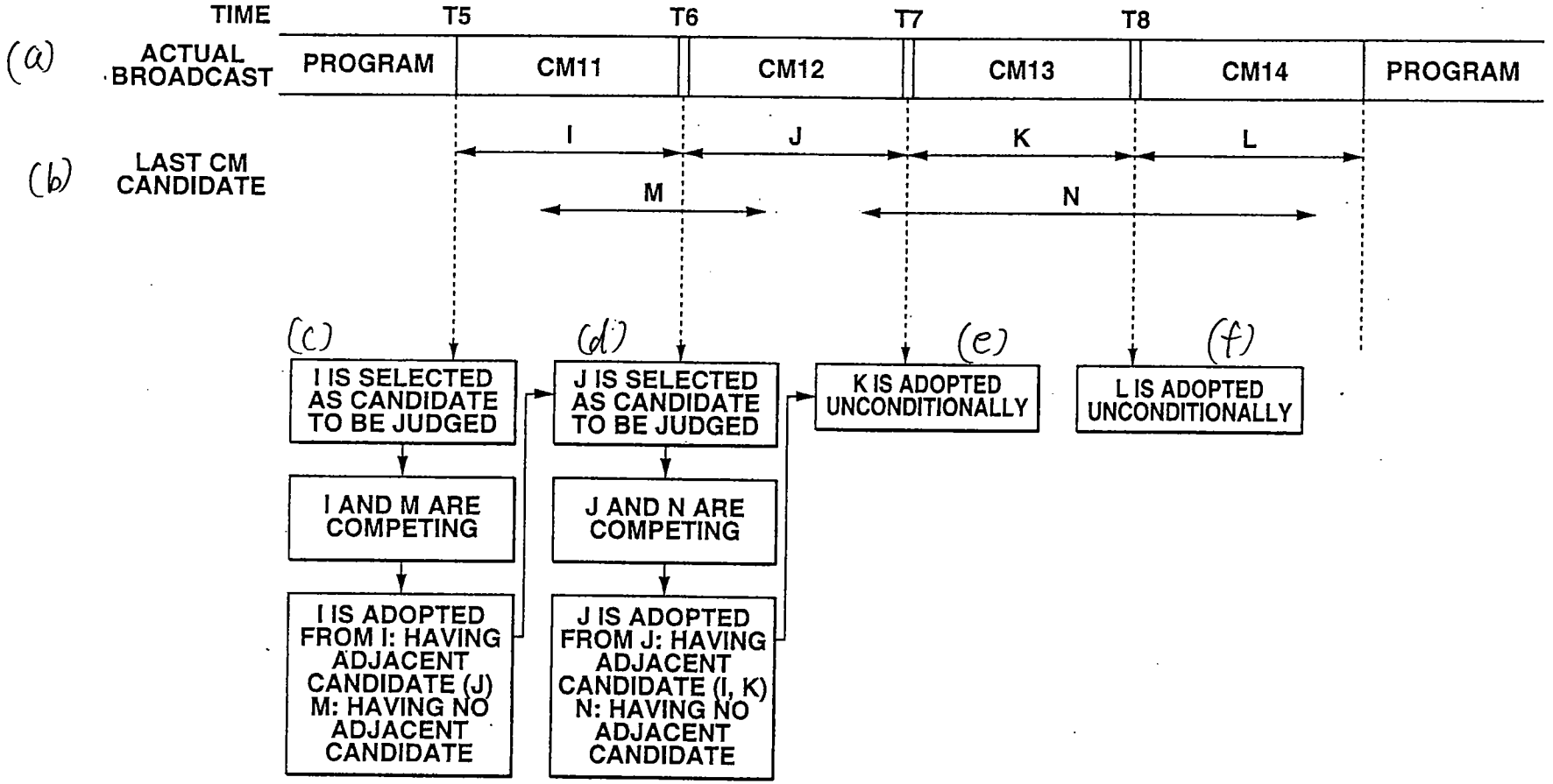
[FIG.24]


START
SELECT CM CANDIDATE TO BE JUDGED
S70
ANY OTHER CANDIDATE EXISTS IN CANDIDATE SECTION ?
S71
NO
YES
APPLY MINIMUM LENGTH PRIORITIZING RULE
S72
CANDIDATE BEING JUDGED DISCARDED ?
S73
NO
YES
ANY OTHER CANDIDATE EXISTS IN CANDIDATE SECTION ?
S74
NO
YES
APPLY ADJACENCY PRIORITIZING RULE
S75
CANDIDATE BEING JUDGED DISCARDED ?
S76
NO
YES
ANY OTHER CANDIDATE EXISTS IN CANDIDATE SECTION ?
S77
NO
YES
APPLY SCORE PRIORITIZING RULE
S78
CANDIDATE BEING JUDGED DISCARDED ?
S79
NO
YES
OUTPUT DETECTED CM
S80

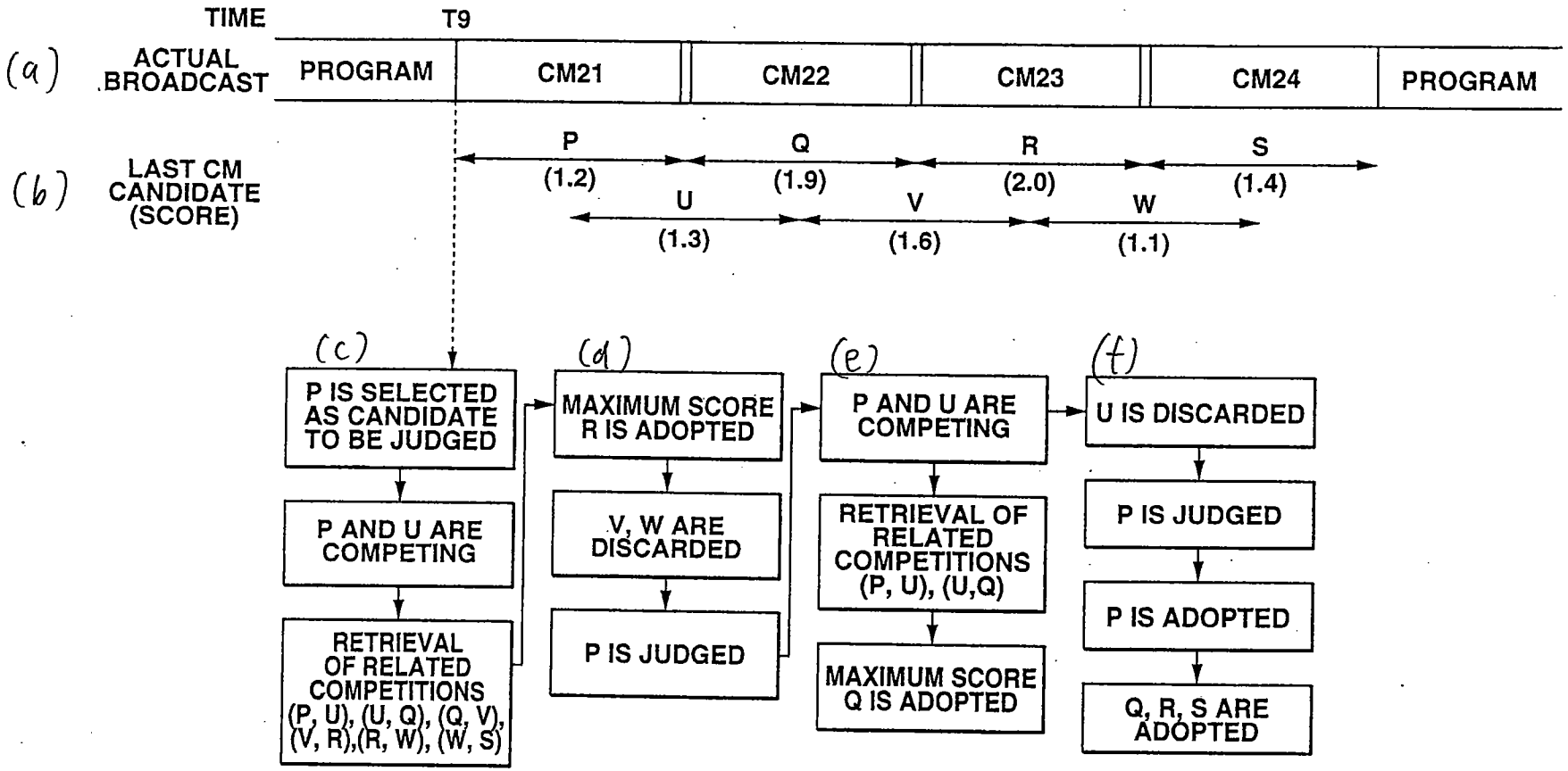
[FIG-25]


TIME
T1
T2
T3
T4
(a)
ACTUAL BROADCAST
PROGRAM
CM1
CM2
CM3
CM4
PROGRAM
(b)
LAST CM CANDIDATE
A
B
C
D
E
F
G
H
(c)
(d)
(e)
(f)
A IS SELECTED AS CANDIDATE TO BE JUDGED
B IS SELECTED AS CANDIDATE TO BE JUDGED
C IS SELECTED AS CANDIDATE TO BE JUDGED
D IS ADOPTED UNCONDITIONALLY
A, E AND H ARE COMPETING
B AND F ARE COMPETING
C AND G ARE COMPETING
A IS ADOPTED FROM E = A + B, H = A + B + C + D
B IS ADOPTED FROM F = B + C
C IS ADOPTED FROM G = C + D

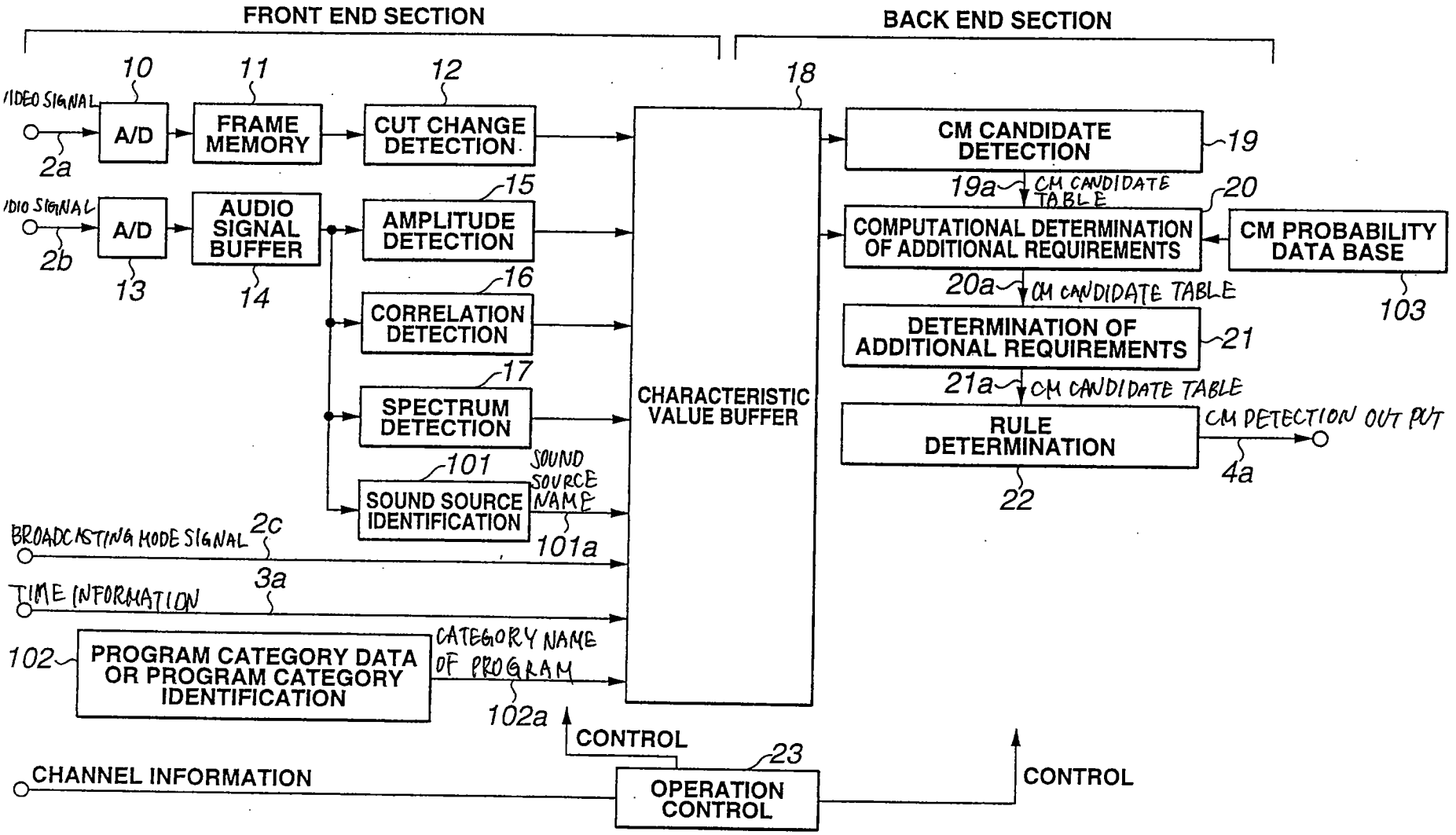
[FIG. 26]


TIME
T5
T6
T7
T8
(a)
ACTUAL BROADCAST
PROGRAM
CM11
CM12
CM13
CM14
PROGRAM
(b)
LAST CM CANDIDATE
I
J
K
L
M
N
(c)
I IS SELECTED AS CANDIDATE TO BE JUDGED
I AND M ARE COMPETING
I IS ADOPTED FROM I: HAVING ADJACENT CANDIDATE (J) M: HAVING NO ADJACENT CANDIDATE
(d)
J IS SELECTED AS CANDIDATE TO BE JUDGED
J AND N ARE COMPETING
J IS ADOPTED FROM J: HAVING ADJACENT CANDIDATE (I, K) N: HAVING NO ADJACENT CANDIDATE
(e)
K IS ADOPTED UNCONDITIONALLY
(f)
L IS ADOPTED UNCONDITIONALLY

[FIG. 27]


TIME
T9
(a)
ACTUAL BROADCAST
PROGRAM
CM21
CM22
CM23
CM24
PROGRAM
(b)
LAST CM CANDIDATE (SCORE)
P
(1.2)
Q
(1.9)
R
(2.0)
S
(1.4)
U
(1.3)
V
(1.6)
W
(1.1)
(c)
P IS SELECTED AS CANDIDATE TO BE JUDGED
P AND U ARE COMPETING
RETRIEVAL OF RELATED COMPETITIONS (P, U), (U, Q), (Q, V), (V, R),(R, W), (W, S)
(d)
MAXIMUM SCORE R IS ADOPTED
V, W ARE DISCARDED
P IS JUDGED
(e)
P AND U ARE COMPETING
RETRIEVAL OF RELATED COMPETITIONS (P, U), (U,Q)
MAXIMUM SCORE Q IS ADOPTED
(f)
U IS DISCARDED
P IS JUDGED
P IS ADOPTED
Q, R, S ARE ADOPTED

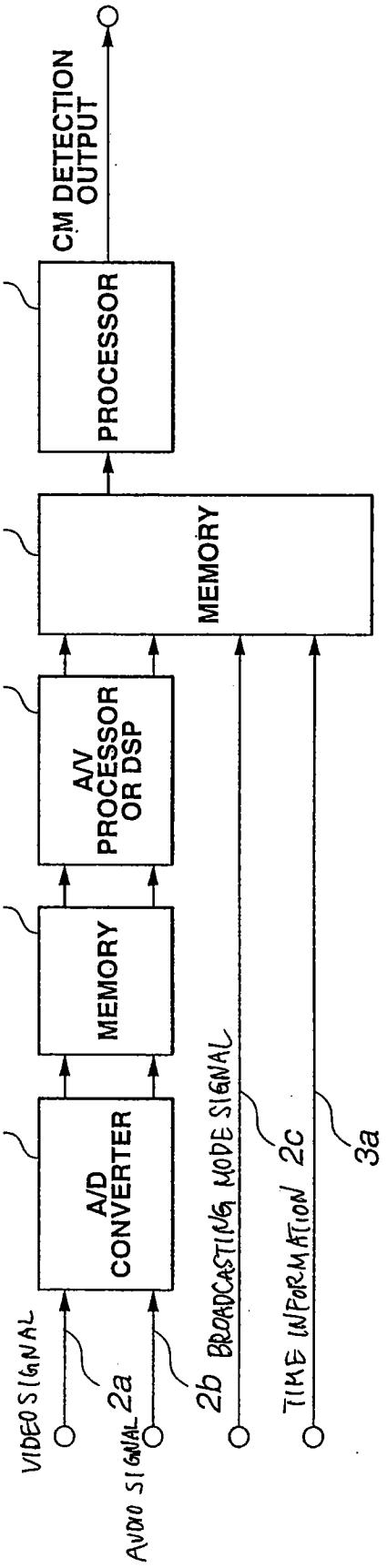
[FIG. 23]


FRONT END SECTION
BACK END SECTION
VIDEO SIGNAL
2a
10
A/D
11
FRAME MEMORY
12
CUT CHANGE DETECTION
IDIO SIGNAL
2b
A/D
13
AUDIO SIGNAL BUFFER
14
15
AMPLITUDE DETECTION
16
CORRELATION DETECTION
17
SPECTRUM DETECTION
101
SOUND SOURCE IDENTIFICATION
SOUND SOURCE NAME
101a
BROADCASTING MODE SIGNAL
2c
TIME INFORMATION
3a
102
PROGRAM CATEGORY DATA OR PROGRAM CATEGORY IDENTIFICATION
CATEGORY NAME OF PROGRAM
102a
CHANNEL INFORMATION
CONTROL
23
OPERATION CONTROL
CONTROL
18
CHARACTERISTIC VALUE BUFFER
CM CANDIDATE DETECTION
19
19a
CM CANDIDATE TABLE
20
COMPUTATIONAL DETERMINATION OF ADDITIONAL REQUIREMENTS
CM PROBABILITY DATA BASE
103
20a
CM CANDIDATE TABLE
DETERMINATION OF ADDITIONAL REQUIREMENTS
21
21a
CM CANDIDATE TABLE
RULE DETERMINATION
CM DETECTION OUT PUT
4a
22

[FIG. 29]

ITEM	SIGN	UNIT	REQUIREMENT EXAMPLE (19a)	ADDITIONAL REQUIREMENT EXAMPLE (20a)	JUDGEMENT EXAMPLE (21a)
PRESENCE OR ABSENCE OF VOICE	Q_{12}	-	-	1	1
PRESENCE OR ABSENCE OF MUSIC	Q_{13}	-	-	1	1
TIME SLOT PROBABILITY	Q_{14}	-	-	0.15	0.15
PROGRAM CATEGORY PROBABILITY	Q_{15}	-	-	0.1	0.1

[FIG 30]


CM DETECTION OUTPUT
44
PROCESSOR
43
MEMORY
42
A/V PROCESSOR OR DSP
41
MEMORY
40
A/D CONVERTER
VIDEO SIGNAL
AUDIO SIGNAL
2a
2b
BROADCASTING MODE SIGNAL
2c
TIME INFORMATION
3a

[Name of Document] ABSTRACT

[Summary]

[Task]

A signal processing device and a signal processing method can accurately detect CMs out of broadcast signals and also be used for storing, accessing, retrieving and viewing/listening to CMs.

[Means for Solution]

CM detecting section (202) detects CM sections out of a broadcast signal. CM extracting section (201) extracts the signal part for the CM section from the broadcast signal on the basis of the CM section detection signal (202a) of the CM detecting section (202) and CM characteristics extracting section (203) extracts the characteristic value of the CM. Then, CM recording section (205) records the signal of the CM section and the characteristic value. CM index generating section (206) generates CM index information by using the signal of the CM section and the characteristic value and characteristics comparing section(204) determines agreement/disagreement of CMs. CM viewing section (208) displays CM retrieval information and reproduce the CM signal from the CM recording scanning (205) in response to the instruction of the user (209). As a result, the user (209) can view,

listen to and retrieve the desired CM.

[Selected Drawing] FIG. 1